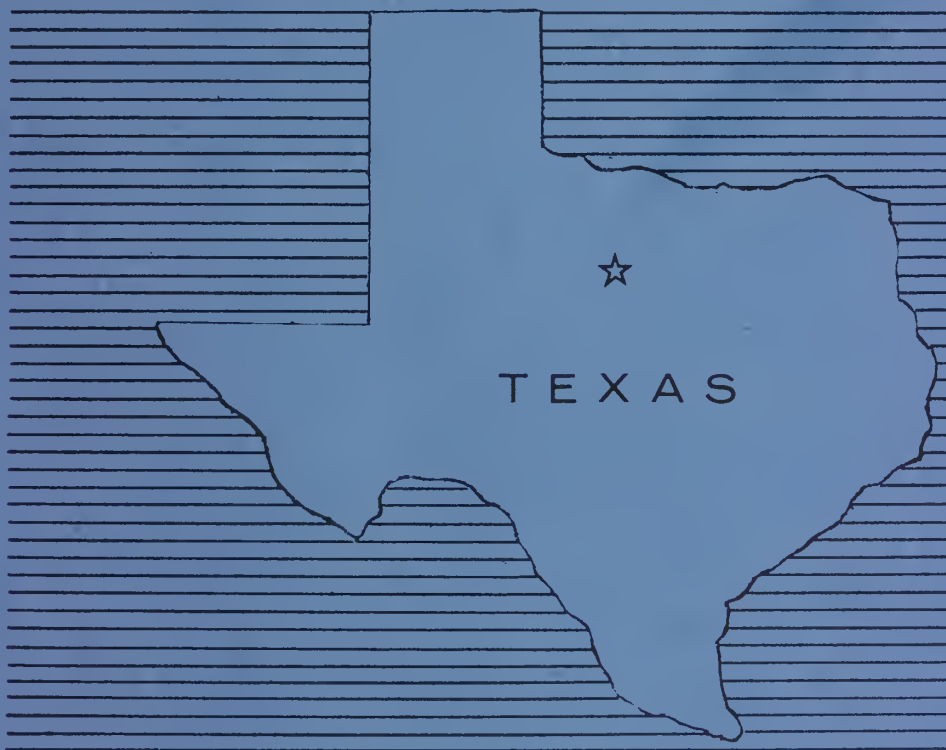
WATERSHED WORK PLAN

KICKAPOO CREEK WATERSHED (LIPAN)

ERATH, HOOD, PALO PINTO AND PARKER COUNTIES, TEXAS



JULY 1973

4-31130 11-73
USDA SCS-FORT WORTH, TEX. 1973

4-31130 12-72

WATERSHED WORK PLAN AGREEMENT

between the

Hood-Parker Soil and Water Conservation District
Local Organization

Bosque Soil and Water Conservation District
Local Organization

Palo Pinto Soil and Water Conservation District
Local Organization

Erath County Commissioners Court
Local Organization

Hood County Commissioners Court
Local Organization

Parker County Commissioners Court
Local Organization

State of Texas
(hereinafter referred to as the Sponsoring Local Organization)

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Kickapoo Creek Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Kickapoo Creek Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about eight years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the federal government such land rights as will be needed in connection with the works of improvement. (Estimated Cost $106,530).

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory service, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	37.78	62.22	0 1/

1/ Investigation has disclosed that under present conditions that project measures will not result in the displacement of any person, business or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
6 Floodwater Retarding Structures	0	100	654,550

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
6 Floodwater Retarding Structures	0	100	39,790

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $2,900 and $108,350 respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

14. No member of or delegate to congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in,be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Hood-Parker Soil and Water Conservation District
Local Organization

By Doyle Hutcheson
Doyle Hutcheson
Title Chairman

Address Weatherford, Texas 76068
Zip Code

Date July 24, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Hood-Parker Soil & Water Conservation District
Local Organization
adopted at a meeting held on March 3, 1973

Albert Porter
(Secretary, Local Organization)
Albert Porter
Address Granbury, Texas 76048
Zip Code

Date July 24, 1973

Bosque Soil and Water Conservation District
(Local Organization

By James Watson
James Watson
Title Acting Chairman

Address Bluff Dale, Texas 76764
Zip Code

Date July 24, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Bosque Soil and Water Conservation District
Local Organization
adopted at a meeting held on July 12, 1973

Jerry Schrimsher
(Secretary, Local Organization)
Jerry Schrimsher
Address Stephenville, Texas 76401

Date July 25, 1973

Palo Pinto Soil and Water Conservation District
Local Organization

By Wm Sanders
William Sanders
Title Chairman

Address Star Route, Strawn, Texas 76475
Zip Code

Date July 25, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Palo Pinto Soil and Water Conservation District
Local Organization
adopted at a meeting held on March 7, 1973

Clydell Lewis
(Secretary, Local Organization)
Clydell Lewis
Address Desdemona, Texas 76445
Zip Code

Date July 25, 1973

Erath County Commissioners Court
Local Organization

By L L Martin
L. L. Martin
Title County Judge

Address Stephenville, Texas 76401
Zip Code

Date July 24, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Erath County Commissioners Court
Local Organization
adopted at a meeting held on February 2, 1971

~~(Secretary, Local Organization)~~
Wm. O. Croft
Wm. O. Croft
Titel: County Clerk
Address ~~Stephenville, Texas 76401~~
Zip Code

Date July 24, 1973

Hood County Commissioners Court
Local Organization

By Milton Meyer
Milton Meyer

Title County Judge

Address Granbury, Texas 76048
Zip Code

Date July 24, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Hood County Commissioners Court
Local Organization
adopted at a meeting held on July 9, 1973

Clarence Holder
(~~Secretary, Local Organization~~)
Clarence Holder
Title: Commissioner
Address Granbury, Texas 76048
Zip Code

Date July 24, 1973

Parker County Commissioners Court
Local Organization

By Bill Word
Bill Word

Title County Judge

Address Weatherford, Texas 76086
Zip Code

Date August 17, 1973

The signing of this agreement was authorized by a resolution of the governing body of the Parker County Commissioners Court
Local Organization
adopted at a meeting held on August 13, 1973

Carol H. Todd
(Secretary, Local Organization)
Carol H. Todd

Address Weatherford, Texas 76086
Zip Code

Date August 17, 1973

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Recommended by:

State Conservationist

Date

Soil Conservation Service
United States Department of Agriculture

By

Date

WATERSHED WORK PLAN

KICKAPOO CREEK WATERSHED (LIPAN)

Erath, Hood, Palo Pinto, and Parker Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666), as amended

Prepared By:

Hood-Parker Soil and Water Conservation District
(Sponsor)

Bosque Soil and Water Conservation District
(Sponsor)

Palo Pinto Soil and Water Conservation District
(Sponsor)

Erath County Commissioners Court
(Sponsor)

Hood County Commissioners Court
(Sponsor)

Parker County Commissioners Court
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

July 1973

USDA-SCS-FORT WORTH, TEX. 1973
4-31130 12-72

WATERSHED WORK PLAN

KICKAPOO CREEK WATERSHED (LIPAN)

Erath, Hood, Palo Pinto, and Parker Counties, Texas

July 1973

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for Kickapoo Creek watershed has been prepared by the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts and the Commissioners Courts of Erath, Hood, and Parker Counties as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources of the watershed.

Financial assistance in developing the work plan was provided by the Texas State Soil and Water Conservation Board.

Kickapoo Creek watershed comprises an area of 81.50 square miles in portions of Erath, Hood, Parker, and Palo Pinto Counties. It is estimated that 23 percent of the watershed is cropland, 13 percent is pastureland and hayland, 62 percent is rangeland, and 2 percent is in miscellaneous uses such as the City of Lipan, public roads, farmsteads, and stream channels.

The principal problem within the watershed is one of extensive and frequent flooding on portions of the 2,960 acres of flood plain which results in damage to crops, grasses, soils, agricultural properties, public roads, and bridges. The total floodwater, sediment, flood plain erosion, and indirect damages are estimated to average $53,240 annually.

Project objectives are the proper use, treatment, and management of soil and water resources in the watershed, the protection of flood plain lands and property, and the stimulation of economic development of the area as a result of project installation. The project as formulated meets these objectives.

Landowners and operators will establish and maintain needed land treatment measures on an additional 2,780 acres of cropland, 4,600 acres of pastureland, and 4,880 acres of rangeland at an accelerated rate during the eight-year installation period, in addition to the maintenance of those measures already applied. Secondary treatment for wildlife habitat management will also be applied. The installation cost of these land treatment measures is estimated to be $461,300, of which $409,400 will be from funds other than Public Law 566. Public Law 566 funds will provide $51,900 to accelerate technical assistance needed for the application of these measures. Of this amount, $2,300 will be used for the completion of needed soil surveys.

4-31130 11-73

The structural measures in this plan are six floodwater retarding structures to be constructed in an eight-year installation period. The total estimated cost of structural measures is $912,120, of which the local share is $109,430 and the Public Law 566 share is $802,690. The local share of the cost consists of land rights and project administration.

Installation of the project will contribute to the conservation, orderly development, and productive use of the watershed's soil, water, and related resources. Watershed lands will be protected from erosion; sediment yielded to flood plain areas will be reduced; and sediment accumulation in Bailey Lake and Lake Granbury will be curtailed. The project will provide protection to 2,960 acres of flood plain land within the watershed and will benefit directly the owners and operators of approximately 50 farms and ranches in the flood plain. Additional water impoundment areas will be created and can be used for recreation, waterfowl feeding and resting areas, development of fisheries, and livestock and wildlife watering areas.

Additional opportunities for employment will be created effecting a greater potential for increased income to households and demand for services.

Installation of the floodwater retarding structures will require 909 acres of agricultural land. A total of 273 acres of this area will be needed for dams, emergency spillways, and sediment pools up to the lowest ungated outlets. The existing vegetation on this 273 acres will be destroyed during construction. However, all exposed areas will be revegetated immediately after construction.

Average annual damages will be reduced from $53,240 to $16,050 by the proposed project. Average annual benefits accruing to the structural measures in the watershed will be $115,550, which includes $34,590 damage reduction benefits, $22,530 more intensive land use benefits, $2,140 incidental livestock water benefits, and $56,290 secondary benefits. The ratio of total average annual benefits accruing to the structural measures ($115,550) to the average annual cost of these measures ($52,710) is 2.2:1.0.

Land treatment measures will be operated and maintained by owners and operators of the land upon which the measures will be applied under agreements with the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts.

The Commissioners Court of Erath County will be responsible for the operation and maintenance of floodwater retarding structures Nos. 1 and 2; the Commissioners Court of Hood County will be responsible for the operation and maintenance of floodwater retarding structures Nos. 3, 4, and 5; and the Commissioners Court of Parker County will be responsible for the operation and maintenance of floodwater retarding structure No. 6. The cost of operation and maintenance of structural measures is estimated to be $1,190 annually.

WATERSHED RESOURCES-ENVIRONMENTAL SETTING

Physical Data

The Kickapoo Creek watershed drainage area is 81.50 square miles (52,160 acres), has an average width of 6 miles and is approximately 17 miles long.

Kickapoo Creek watershed is located in north-central Texas about 50 miles southwest of Fort Worth. Kickapoo Creek rises in the extreme northeastern corner of Erath County about 15 miles north of Stephenville. Following a northeastward course, the main stem crosses the northwestern corner of Hood County, passing closely by the community of Lipan, and enters southwestern Parker County where it joins the Brazos River. The Brazos River and its tributaries are in the Texas Gulf Water Resource Region. The extreme southeastern corner of Palo Pinto County is also drained by Kickapoo Creek.

Major tributaries of Kickapoo Creek are Dry Branch, Crockery Creek, Rocky Creek, Onion Creek and Cottonwood Creek. Most of the stream channels are usually dry except during times of surface runoff. However, a few small seasonal springs discharge a minor amount of streamflow. The spring discharge is dependent upon at least near normal rainfall in the watershed and immediate area. Kickapoo Creek, the main stem creek in the watershed, has a total length of about 34 miles of stream channel. Of this, about 30 miles have intermittent stream channel flow and 4 miles have ephemeral flow. The ephemeral flow occurs in two separate stream reaches which are located from the Brazos River upstream to where Cottonwood tributary joins Kickapoo Creek and between the site of planned floodwater retarding structure No. 2 and Bailey Lake (figure 4).

Bailey Lake is a small privately owned reservoir located on Kickapoo Creek about 1.5 miles southwest of Lipan. DeCordova Bend Dam is located on the Brazos River about 11 miles downstream from Granbury, Texas. The resultant impoundment, Lake Granbury, extends upstream to about two miles below the confluence of Kickapoo Creek and the Brazos River.

The watershed contains outcrops of Quaternary, Cretaceous, and Pennsylvanian sedimentary strata. Removal of Cretaceous rocks by geologic erosion has resulted in exposure of Pennsylvanian limestone, shale, sandstone, and conglomerate beds belonging to the Strawn Group. The exposure exists as an inlier occupying the inner 24 percent of the watershed along and adjacent to Kickapoo Creek. Kickapoo Falls, located on Kickapoo Creek about four miles northeast of Lipan, is formed by a very hard 10 to 12 foot thick limestone member of the Strawn Group. Cretaceous sand, clay, and soft conglomerate of the Twin Mountains Formation rest unconformably upon the Pennsylvanian beds and surround the inlier. The outcrop of the Twin Mountains Formation covers 57 percent of the watershed. Alternating beds of Cretaceous limestone, silt, and clay, occupy the higher elevations in the southern and western 19 percent of the watershed and form a protective cap above the more easily eroded Twin Mountains Formation. The protective beds belong to the Glen Rose Formation.

The Quaternary strata consist of sand, clay, and gravel terrace deposits near the Brazos River and the Recent Alluvium along Kickapoo Creek and its major tributaries. The Recent Alluvium, derived mainly from materials of the Glen Rose Formation, consists mostly of clay and silt.

The topography is nearly level on the flood plain, rolling to gently rolling on the outcrops of the Strawn Group and the Twin Mountains Formation, and rolling to steeply sloping on the outcrop of the Glen Rose Formation. Elevations range from nearly 1,300 feet above mean sea level on the western divide to about 700 feet at the Kickapoo Creek-Brazos River confluence.

Three major land resource areas occur within the watershed. Generally, the Central Rolling Red Prairies Land Resource Area occurs on the geologic Strawn outcrop, the Cross Timbers occurs on the Twin Mountains outcrop, and the Grand Prairie occurs on the Glen Rose outcrop. Quaternary strata occur within all three land resource areas.

Soils of the Central Rolling Red Prairies Land Resource Area are primarily clays, clay loams, fine sandy loams, loamy fine sands, and stony clay loams of the Thurber, Tobosa, Stamford, Truce, Bonti, Chaney, Hensley, Demona, and Blanket series.

The Cross Timbers Land Resource Area is composed of fine sandy loams and fine sands of the Windthorst, May, Dougherty, and Nimrod soil series.

The Grand Prairie Land Resource Area in the watershed is characterized by clay and clay loam soils of the Purves, Dugout, Krum, Tarrant, Denton, Lewisville, Frio, and Bosque series.

The climax plant community of the Central Rolling Red Prairie and Cross Timbers Land Resource Areas is generally a post oak savannah. The primary decreasers include little bluestem (Andropogon scoparius), big bluestem (Andropogon gerardi), and Indiangrass (Sorghastrum nutans). Grasses which increase with overgrazing are sideoats grama (Bouteloua curtipendula), Texas wintergrass (Stipa leucotricha), and silver bluestem (Andropogon saccharoides). Common invaders include threeawns (Aristida spp.), sand dropseed (Sporobolus cryptandrus), and hooded windmillgrass (Chloris cucullata). Post oak increases with overgrazing and may become dominant. Mesquite is a common woody invader on the soils of these resource areas.

The Grand Prairie Land Resource Area varies from a true prairie to a post oak and live oak savannah in climax condition. Elm, pecan, hackberry, and other woody species are numerous in the climax communities but confined to watercourses. Primary decreasers include Indiangrass, big bluestem, and little bluestem. Increaser species are sideoats grama, silver bluestem, Texas wintergrass, dropseeds (Sporobolus spp.), hairy grama (Boutaloua hirsuta), and buffalograss (Buchloe dactyloides). Invading species include Texas grama (Boutaloua Rigidiseta), red grama (Boutaloua trifida), threeawns, and queensdelight (Stillingia sylvatica). Mesquite is a major invader on some range sites.

Much of the vegetation within the watershed bears little resemblance to its climax condition. Overuse by grazing animals has destroyed or altered

plant species and composition to a marked degree on more than 90 percent of the rangeland. Dominant climax grass plants such as Indiangrass and little bluestem have been replaced by less productive species such as Texas wintergrass, sideoats grama, buffalograss, and threeawns on a majority of rangelands. Perennial forbs of value as wildlife and livestock forage have been largely eliminated. Woody species such as post oak and mesquite dominate about 13,000 acres of the watershed to a degree which adversely affects forage production. Hydrologic cover conditions range from poor to good with more than 80 percent in fair condition.

Land use within the watershed is shown in the following tabulation:

Land Use	Acres	Percent
Cropland	11,900	23
Pastureland and Hayland	6,760	13
Rangeland	32,170	62
Miscellaneous *	1,330	2
Total	52,160	100

* Includes roads, highways, urban areas, farmsteads, stream channels, etc.

The present land use within the flood plain area is approximately 1,036 acres of cropland which are devoted to production of oats, sudan hay, and a small amount of cotton; and 1,865 acres of pastureland of which about 265 acres are improved pastureland; and 59 acres are roads and other miscellaneous uses.

The climate is warm and subhumid. Mean monthly temperatures range from 44 degrees Fahrenheit in January to 84 degrees in July. The normal growing season, extending from late March to early November, is about 230 days. The average annual rainfall is about 32 inches.

Water for livestock and rural domestic use is obtained from ponds, spring fed streams, and shallow, low producing wells. Lipan obtains its water supply from Bailey Lake which is fed by spring flows that issue from the base of the Twin Mountains Formation. During prolonged periods of drought, these are not reliable sources of water.

There are no known mineral resources of economic significance within the watershed.

Economic Data

The economy of the watershed is dependent largely on agriculture. The sale of livestock, poultry, and related products accounts for 90 percent of the on-farm income within the watershed. The remaining 10 percent is derived from the sale of crops including peanuts, grain sorghum, cotton, small grains, and hay.

Major crops grown on the flood plain and average yields per acre are oats, 35 bushels; hay crops, 2.5 tons; and improved pastureland, 4 animal unit months of grazing.

During recent years, the trend in both upland and flood plain has been toward increased livestock production. This has resulted in the shifting of cropland from cash crops to forage and hay crops and improved pastureland. Some unimproved and brushy pastureland has been established to improved grasses and hay crops.

There are approximately 200 farm and ranch units wholly or partially within the watershed. These units average about 250 acres in size and range from less than 50 to more than 1,000 acres. About 73 percent of the farms and ranches are smaller than 220 acres. There has been a gradual increase in size and a decrease in the number of farms. About 90 percent of the agricultural land is owner-operated.

The estimated current market price of land ranges from $125 to $400 per acre. The range in land prices depends on location, accessibility, and soil capability.

Based on 1969 Agricultural Census data for Erath, Hood, Palo Pinto, and Parker Counties, about 51 percent of the farms and ranches gross less than $2,500 annually from agricultural sales. Approximately 56 percent of the farm and ranch operators worked off-the-farm 100 days or more in 1969. The average value of land and buildings per farm and ranch is estimated at about $77,000.

It is estimated that less than five percent of the agricultural land in the flood plain area is in operating units using one and one-half man years or more of hired labor.

The "Work Force Estimates for Nonmetropolitan Counties in Texas for April 1972", the latest statistics which are available, shows a labor force of 24,925 or 28.5 percent, from a total population of 87,349 for the four counties within which the watershed is located. Slightly over 5.1 percent, or 1,280 workers are unemployed. This is comparable to both the state and national rate of unemployment. Approximately 12.6 percent, 3,130 workers are employed in the agricultural sector. The nonagricultural sector employs 20,515 workers; 3,015 workers in the manufacturing sector, and 17,500 in the nonmanufacturing sector.

The incorporated City of Lipan, with a population of 333, is located in the upper portion of the watershed. Nearby towns and their approximate distances from Lipan are: Granbury, 15 miles southeast; Mineral Wells, 25 miles northwest; Stephenville, 24 miles southwest; and Weatherford, 31 miles northeast. These towns provide the needed services and marketing facilities for the area. The large industrial and metropolitan city of Fort Worth is approximately 55 miles to the northeast.

Approximately 83 miles of state and county roads, of which about 33 miles are hard-surfaced, serve the watershed residents.

Erath County is within the boundaries of the Leon-Bosque Resource Conservation and Development Project area.

4-31130 11-73

Fish and Wildlife Resources

The fish and wildlife habitat, species, and populations in the watershed are described by the Bureau of Sport Fisheries and Wildlife as follows:

> "Fish habitat in the project area is limited to permanent pools in the intermittent creeks, farm ponds, and three small private reservoirs.
>
> The principal fish species in the watershed are largemouth bass, bluegill, redear and green sunfish, channel catfish, gizzard shad, carp, and river carpsucker. There is some fishing by landowners and their friends on private property.
>
> Important game species in the watershed are white-tailed deer, bobwhite, and mourning dove. Other wildlife species present include fox squirrel, cottontail, oppossum, raccoon, gray fox, red fox, bobcat, coyote, ring-tailed cat, and skunk. A few water fowl pass through the project area during spring and fall migration.
>
> The deer population is moderate in numbers in the southeast portion of the watershed and low elsewhere. Deer hunting is light to moderate, and most of it is on a lease basis. Squirrel numbers are modest along the water courses and low elsewhere. These animals receive moderate hunting. Quail are found in low to moderate numbers in the project area, and hunting for them is medium to heavy. Mourning doves are present in fair numbers in most of the watershed, and there is much interest in hunting them. Little duck hunting is done in the watershed because of low populations. There is some interest in sport hunting for raccoons, bobcats, foxes, and coyotes. Some raccoons are trapped for their fur."

The watershed is within the winter range of the peregrine falcon and southern bald eagle and on the western edge of the migration route of the whooping crane. These birds are all considered to be endangered species.

Recreational Resources

There are opportunities for fishing and hunting in the watershed and surrounding area. Fish and wildlife species of significance in the watershed are described under Fish and Wildlife Resources.

Lake Granbury, in addition to providing opportunities for fishing, furnishes other water-based recreation such as boating, water-skiing, swimming and picnicking.

Archeological and Historical Values

There are no historic sites listed or in the process of nomination to the National Register of Historic Places. There are no known archeological resources of significance within the watershed.

Soil, Water, and Plant Management Status

There are 126 farm and ranch units wholly or partially within the watershed under district agreement with the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts. Soil Conservation Service field offices at Granbury, Stephenville, Weatherford, and Mineral Wells are assisting the districts in preparing and applying soil and water conservation plans.

Soil and water conservation plans are developed by landowners or operators in cooperation with the appropriate soil and water conservation district with technical assistance provided by the Soil Conservation Service. These plans set a course of action for the use, maintenance, and improvement of the soil, water, and related resources of an entire individual land unit. Included in these plans are appropriate soil, plant, and water inventories with needed interpretations, maps, statements concerning critical conservation problems, a record of decisions for the conservation and development of soil and water resources as made, and alternatives for sound land uses and conservation treatment.

Conservation plans have been developed for all 126 farm and ranch units which are under agreement and cover 70 percent of the agricultural land in the watershed. There are no serious upland erosion problems resulting from improper use of land in the watershed. Soil surveys, which are essential for development of sound conservation plans, have been completed on obout 80 percent of the watershed or nearly 40,000 acres and are needed on the reamining watershed area. Land treatment measures which have been applied to date at an estimated expenditure of $473,500 by landowners and operators (table 1A) amount to about 45 percent of the total treatment needed.

Over half of the flood plain lands are utilized far below their potential. Farm and ranch operators are not able to establish improved grasses, plant high producing feed crops, or fertilize to any significant extent on much of the flood plain because flooding may occur at any time and result in severe damage or reduce greatly the effectiveness of fertilizers and other monetary inputs associated with management practices.

In forested flood plains, the landowners can be provided with a range of management alternatives for their lands. The Texas Forest Service, in cooperation with the U.S. Forest Service, is available to help the landowners develop forest management plans for these and other woodlands under existing and active Cooperative Forest Management programs. Forest management possibilities include: tree planting and stand improvement measures and the enhancement of the water related capabilities of the forest, and other forest uses including wood products, wildlife habitat, recreational resources, esthetics, and climatic influences.

Trends in floodplain and upland areas have resulted in the shifting of cropland from cash crops to pastureland and hayland. Presently, 75 percent of the watershed is used as rangeland and pastureland.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Management Problems

There is a constant need to apply and maintain land treatment that reduces or controls erosion. The deep sandy and silty soils of the Cross Timbers Land Resource Area (57 percent of the watershed) are inherently susceptible to water and wind erosion when cultivated or overgrazed. In addition, the sandstone, clay and conglomerate bedrock under these soils are generally very poorly indurated and highly subject to accelerated erosion when denuded.

Erosion problems have been controlled on much of the watershed by changing the land use from cropland to grassland. This change has resulted primarily from a shift from a cash crop economy to a livestock economy. It is imperative that sound conservation practices be applied by landowners and operators to control erosion on upland and floodplain areas.

Floodwater Damage

The flood plain consists of 2,960 acres excluding stream channels. This is the area that will be inundated by a 100-year frequency flood (figure 1).

Flooding occurs frequently and causes moderate to severe damages to crops, pastures, fences, farm improvements, public roads, and bridges. Major floods, inundating more than half of the flood plain, occur on the average of once every three to four years. Minor floods, inundating less than half of the flood plain, occur on the average of two or three times a year. Cumulative totals of recurrent flooding show an average of 1,203 acres flooded annually during the evaluation period. Damage to flood plain lands from deposition of sediment and flood plain scour has resulted in reduction of crop yields and caused some shift of cultivated land to pastureland and hayland. The deposition of debris is also a problem.

Over half of the flood plain lands are utilized far below their potential. Because of frequent flooding, farm and ranch operators are not able to establish improved grasses, plant high producing feed crops, or fertilize to any significant extent on much of the flood plain because flooding may occur at any time and result in severe damage or reduce greatly the effectiveness of fertilizer and other monetary inputs associated with management practices.

The most disastrous flood in recent years occurerd April 27-28, 1957. The total rainfall recorded at Lipan was 5.67 inches. This was in addition to prior rains that fell during the period of April 20-26, when 3.58 inches was recorded. The recurrence interval of the resulting flood peak was estimated to be about 25 years. Floodwaters inundated approximately 2,675 acres of flood plain. Damagesto crops, pasture grasses, fences, other agricultural properties, and roads and bridges were severe. Over 40 percent of the flood plain was damaged by deposition of infertile sediment or scour. Numerous county roads were closed, some for several weeks before repairs could be made. Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be $104,430.

Average annual flooding exceeds 1,200 acres.

4-31130 12-71

Other recent large floods that caused extensive floodwater damages occurred in 1967, 1955, 1952, and 1949.

A flood resulting from a 100-year frequency storm event would cause direct floodwater damages in excess of $150,700.

For the floods evaluated, which includes floods up to and including a 100-year frequency event, a total direct floodwater damage is estimated to average $29,550 at adjusted normalized prices (table 5). Of this amount, $10,450 is crop and pasture damage, $9,470 is other agricultural damage, and $9,630 is road and bridge damage.

Erosion Damage

The estimated annual rate of upland erosion on the watershed averages 2.46 tons per acre. Of this, sheet erosion accounts for 79 percent, gully erosion 17 percent, and streambank erosion 4 percent. Although erosion rates have been reduced greatly by land treatment and land use conversions, there remain small areas where rapid erosion is occurring on cultivated and formerly cultivated fields and on overgrazed grassland. Some active gullying is still taking place, but a definite trend toward rapid healing is evident.

The stream channels are generally in a very stable condition. The only significant channel erosion is found on the outside banks of very sharp meanders. Stream beds are neither aggrading nor degrading noticeably.

Severe erosion has occurred on the soils of the flood plain. Some cropland has been converted to grassland because of frequent and critical soil losses caused by scour. Much of the remaining cropland on the flood plain still suffers moderate to severe scour damage. The damaged areas range from broad sheet scour depressions to narrow channels 0.5 to 3.0 feet in depth. It is estimated that flood plain scour causes a loss of productive capacity on 889 acres which is distrubuted as follows: 449 acres, 10 percent; 393 acres, 20 percent; and 47 acres, 30 percent. The average annual value of this damage is estimated to be $8,670 (table 5). Annual recovery from flood plain scour is approximately in balance with new damage.

Sediment Damage

The estimated average annual sediment production rate at the mouth of Kickapoo Creek is 0.88 tons per acre. This amounts to an average annual sediment yield of about 46,000 tons. Sediment derived from the watershed is a source of pollution in the Brazos River, degrading the quality of water for all present and probable future uses. The estimated average suspended sediment concentration at the lower end of the watershed is 1,800 parts per million based on 2.09 inches of average annual runoff from the watershed. No estimate of the monetary damage as a result of this concentration has been made.

The storage capacity of Lake Granbury on the Brazos River is depleted by an estimated average of 33 acre-feet annually by sediment derived from

Crop loss and scour damage to flood plain land.

Damages occur frequently to roads and fences.

4-31130 12-71

Kickapoo Creek watershed. The estimated average annual value of this damage is $3,480 (table 5).

The storage capacity of Bailey Lake, the present water supply for the City of Lipan, is depleted by an estimated average of five acre-feet annually due to sediment deposition. The estimated average annual value of this damage is $500 (table 5).

Within the watershed, damaging sediment is deposited on roads and bridges, in farm ponds, and on productive agricultural flood plain land. Deposition on the flood plain consists primarily of silty sand, fine to medium sand, and silty clay. These deposits, ranging from 0.5 to 3.5 feet thick, primarily overlie fertile clay loam and are estimated to have reduced the productive capacity of 402 acres of flood plain soils as follows: 107 acres, 10 percent; 169 acres, 20 percent; 66 acres, 30 percent; and 60 acres, 40 percent. The average annual value of this damage is estimated to be $6,200 (table 5).

Field investigations indicate that sediment was deposited on areas of the flood plain at an accelerated rate in the past. It is believed that this condition existed in the 1930's and 1940's when a large percentage of the watershed was cultivated and severe erosion was occurring. As a result of conservation land treatment and the conversion of much cropland to pastureland, the erosion rates and related sediment damages have been greatly reduced. It is estimated that the present rate of overbank deposition is in equilibrium with the rate of revovery.

Indirect Damages

Indirect damages such as interruption or delay of travel, rerouting of school buses and mail routes, disruption of farm operations, business losses in the area, and similar losses are estimated to average $4,840 annually.

Irrigation

Irrigation in the watershed is minor and is limited to a few small areas irrigated on a supplemental basis. Wells in the Twin Mountains Formation are the source of water. During periods of prolonged droughts, these wells generally will not furnish a reliable supply of water.

There has been no interest expressed in storing additional irrigation water in surface impoundments.

Municipal and Industrial Water

The quantity and quality of water from Bailey Lake, the source of water for the City of Lipan, are presently adequate during years of normal or near normal rainfall. The reservoir is fed by spring flow from sands of the Twin Mountains Formation. However, the flow of water stops during prolonged droughts.

Wells in the Twin Mountains Formation are generally not reliable during prolonged periods of drought. This condition exists because the recharge

area is a very localized outcrop of the formation extending to the west and northwest just beyond the Kickapoo Creek watershed divide, and low permeability rates of sand members within the formation.

The population of Lipan is 333. The population and consequently the demand for larger quanties of water are not expected to appreciably in increase in the future. However, continued sediment accumulation in Bailey Lake will continue to deplete the available quantity and present quality.

Economic and Social

Additional employment oppoutunities are needed for the 1,280 unemployed workers in the area. The population of Lipan increased from 309 persons in 1960 to 333 persons in 1970. Further increases in population could be anticipated with a concentrated effort in community development and additional employment opportunities.

PROJECTS OF OTHER AGENCIES

There are no existing or proposed water resource development projects of any other agencies within the watershed.

DeCordova Bend Dam, completed in 1969 by the Brazos River Authority, is located on the Brazos River about eleven miles downstream from Granbury. The resultant impoundment, Lake Granbury, extends upstream to about two miles below the mouth of Kickapoo Creek. The reservoir provides 44,600 acre-feet of sediment storage and 105,400 acre-feet of conservation storage for municipal, industrial, and irrigation water supplies.

The works of improvement included in this work plan will have no known detrimental effects on any existing or proposed downstream works of improvement, and will constitute a harmonious element in the full development of the Brazos River Basin. The application of the planned land treatment and the installation of the six floodwater retarding structures will reduce sediment in the Brazos River and sediment accumulation rates in Lake Granbury.

PROJECT FORMULATION

Prior to the initiation of planning and during the planning phase, informational meetings were held. These meetings were conducted in the watershed by local organizations. The initial meeting, held in Lipan, Texas and attended by 75 interested citizens, was sponsored by a local civic organization. It was recognized at this meeting that favorable public opinion toward a watershed project was needed before submitting an application for planning assistance to the Texas State Soil and Water Conservation Board. It was also emphasized at this meeting that under the auspices of Public Law 566, a watershed project would be a local endeavor with federal assistance. With the ensuing endorsement by those present to take positive action, the Kickapoo Creek Watershed Association was formed to serve as a steering committee to draft an application for planning assistance and to coordinate and carry out local responsibilities during planning.

Subsequent meetings were held by the sponsoring local organizations to inform the general public and involved landowners and to gain opinions and information from interested individuals. A tour and hearing was conducted to observe the status of land treatment, damages from past floods, and potential benefited areas from a flood-prevention program. Landowners and operators were shown how their properties were involved in potential floodwater retarding structures with the use of maps and on-site observations.

Newspapers serving the watershed area published articles announcing public meetings and reported information and conclusions resulting from the meetings. In addition, the individuals whose land was directly involved with potential floodwater retarding structures were notified and invited on an individual basis to attend meetings.

Objectives

An initial study was made by representatives of the Soil Conservation Service and sponsoring local organizations to determine watershed problems and possible solutions. After determining the location and extent of the problems and discussing potential solutions, project objectives were formulated. Watershed protection and floodwater prevention were the primary objectives expressed by the sponsors. The City of Lipan also wished to consider the feasibility of obtaining a supplemental municipal water supply from a multiple-purpose structure.

In addition to expressing the desire for establishment of a complete program for soil and water conservation on the watershed, the following specific objectives were agreed to:

1. Establish land treatment measures which contribute directly to watershed protection and flood prevention with a goal of at least 70 percent of the watershed adequately treated by the end of the project installation period.

2. Attain a reduction of 65 to 70 percent in average annual flood damage to agricultural flood plain lands, with a minimum of about 60 percent reduction in any one agricultural reach.

3. Investigate the feasibility of including municipal and industrial water storage in a multiple-purpose structure for immediate use as the principal source of supply for the City of Lipan.

Environmental Considerations

The sponsors considered the impacts both favorable and adverse, in developing the plan for meeting the project objectives. The objectives selected were those that would contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources so that watershed residents can enjoy:

QUALITY IN THE NATURAL RESOURCE BASE FOR SUSTAINED USE

QUALITY IN THE ENVIRONMENT TO PROVIDE ATTRACTIVE, CONVENIENT, AND SATISFYING PLACES TO LIVE, WORK, AND PLAY

QUALITY IN THE STANDARD OF LIVING BASED ON COMMUNITY IMPROVEMENT AND ADEQUATE INCOME

The sponsors selected measures which will help to achieve these objectives and also included measures to minimize adverse impacts wherever practicable.

Land treatment measures planned for the watershed are those that will contrubute directly to the preservation and enhancement of the environment of the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the floodwater retarding structures, reduce flooding, and preserve and improve the fish and wildlife resources of the watershed.

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the watershed and submitted nine recommendations for the preservation, enhancement, and use of fish and wildlife resources in the watershed. The sponsoring local organizations and the Service considered these recommendations in formulating the land treatment and structural measures in the work plan. After careful study, six of these recommendations were determined to be highly desirable and feasible and were incorporated in the land treatment to be installed. Included in these recommendations is planting of woody vegetation. This woody vegetation will be adapted to existing conditions and established in conjunction with erosion control plantings on disturbed areas above and below the earth embankments.

The recommendation concerning the fencing of sediment pools was not included in the work plan. Long time observations at other floodwater retarding structures constructed on the same or similar soils have not evidenced any significant degree of fouling of water by livestock which would adversely effect reservoir fisheries.

The other two recommendations suggesting floodwater retarding structure sediment pools and farm ponds be opened to the public for fee fishing, and the establishment of hunting and fishing cooperatives with members selling hunting and fishing permits, were considered to be contingent upon the prerogatives of the individual landowners and operators and were not included as an integral part of the work plan.

During work plan development, extensive studies were made by the sponsoring local organizations and the Service to avoid or at least minimize the displacement or relocation of individuals, farms, and businesses. There are no apparent relocations or displacements that will be caused by installation of the project.

Alternatives

The considered alternatives to the proposed project action were: (1) an accelerated program of applying land treatment measures for watershed

protection, (2) changing the present use of flood plain land to uses that are less susceptible to damage by flooding, and (3) foregoing the implementation of a project.

A discussion of each alternative follows:

Alternative No. 1 - This alternative consisted of applying the land treatment measures as proposed in the project action. Most of the impacts of the application of land treatment measures are discussed under environmental impact of the proposed action. Average annual damages from floodwater would be reduced by about 4.9 percent in downstream areas. The volume of sediment being delivered to the mouth of the watershed would be reduced from 36 acre-feet annually to 33 acre-feet, a reduction of 8.3 percent. Sediment originating in the watershed and deposited in Lake Granbury would be reduced from 33 acre-feet to 30 acre-feet annually, a 9.0 percent reduction. Deposition of sediment in Bailey Lake would be reduced from 5.0 acre-feet to 4.0 acre-feet annually. This alternative would have little effect in reducing flood plain scour on cultivated land and in reducing the volume of sediment produced by this process. The adverse impacts caused by installation of the floodwater retarding structures would be eliminated. The estimated cost of this alternative is $461,300.

Alternative No. 2 - This alternative consisted of changing the present use of the land to one that is less susceptible to damage by flooding.

The potential land uses, listed in order from highest to lowest susceptibility to flood damage, are cropland, pastureland, and rangeland. Land used for other purposes, such as transportation systems, are damaged to varying degrees by flooding, depending upon the type of development and depth and duration of flooding.

In order to substantially reduce the need for flood protection, it would be necessary to convert 1,027 acres of cropland and 258 acres of improved pastureland to unimproved pastureland, rangeland, woodland, or wildlife-recreation land if extensive developments were not installed. This alternative would significantly reduce the actual monetary damage caused by floodwater, sediment, and erosion. Changing the land use from cropland would reduce the food supply for many species of wildlife that are present in the watershed. Damages to the transportation system would continue at about the same rate because it would be impractical to move the system out of the flood hazard area. The economic returns to the owners and operators of 2,960 acres of agricultural land in the flood hazard area would be reduced by about $90,000 annually if the land use were changed to rangeland.

Alternative No. 3 - Alternative No. 3 consisted of foregoing the implementation of a project.

This would delay the application of land treatment measures, which would delay the impact these measures have on reducing sediment production from the watershed and would also delay the impact these measures have in reducing flood damage. It is reasonable to expect, however, that landowners and operators would eventually install the land treatment measures to maintain the productivity of their lands. Flooding would continue, resulting in damage to agricultural land and the transportation system. The deterioration of the cultivated flood plain soils by scour would continue until the cumulative effect of this damage forced land use conversion to less productive uses. Areas subject to scour and streambank erosion would continue to produce sediment.

The need to use 909 acres of land for the installation of the structural measures and resultant adverse impacts would be eliminated.

The opportunity to realize about $62,840 in average annual net benefits would be foregone.

Several systems of floodwater retarding structures were evaluated in developing the work plan. In selecting potential sites for floodwater retarding structures, consideration was given to locations which would provide the agreed upon level of protection to areas subject to damage. The size, number, design, and cost of the structures were influenced to a high degree by the physical, topographic, and geologic conditions in the watershed.

Investigations were made for the feasibility of a multiple-purpose structure for Lipan. Floodwater retarding structure No. 2 and an alternate site approximately one mile downstream near Bailey Lake were investigated in detail for this purpose. Both floodwater retarding structure No. 2 and the downstream alternate site have the potential for water impoundment. It was determined that municipal water could be supplied by a multiple-purpose structure at either of the elected sites. The basic site information for multiple-purpose storage was reviewed with the sponsoring local organizations at several meetings. After considerable evaluation of the alternatives, the sponsors decided not to include municipal water storage as a purpose at either site location. Financial limitations, limited sources of revenue, low population growth rate, and costs for additional facilities to operate a public water supply system were the major reasons for excluding municipal water storage.

Upon completion of studies to ascertain the location and extent of flood problems, nine structure site locations were selected for evaluation of their effects on watershed problems. Preliminary surveys and investigations were made at site locations on Weaver Branch and Cottonwood Creek. Studies indicated that developed areas within the City of Lipan are not subject to flooding from Weaver Branch by the project evaluation flood and that floodwater damages to agricultural properties on the flood plains of both Weaver Branch and Cottonwood Creek are minor. Control of runoff from these tributaries is not necessary to achieve the desired level of protection along the mainstem flood plain of Kickapoo Creek. Therefore, no detailed investigations were made at these locations.

Detailed surveys and investigations made at seven site locations included two alternate locations on Kickapoo Creek. Studies conducted showed that six floodwater retarding structures, including the upper alternate location on Kickapoo Creek, was the most feasible system of structural measures to meet project objectives for flood prevention to flood plain lands at the least cost. The floodwater retarding structures also provide incidental livestock water benefits at no additional cost.

Alternatives for similar watershed protection and flood prevention in the watershed without the technical and financial assistance provided under the authority of Public Law 566 are nonexistent at the present time. The burden of funding planning and construction entirely from local financing would preclude the initiation of such a project.

WORKS OF IMPROVEMENT TO BE INSTALLED

Conservation Land Treatment

The use of each acre of land within its capabilities and its treatment in accordance with its needs has long been accepted as one of the foundations for the building of a strong and free community, state, or nation. Sponsors of this project are keenly aware of this concept and deem the installation and maintenance of needed land treatment measures as essential.

Conservation land treatment consists of individual measures and practices or a combination of measures and practices that are planned, installed, and maintained on privately owned land by individuals or groups of landowners and operators or by local organizations. Land treatment measures planned for the watershed are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the structural measures, reduce flooding, and preserve and improve the fish and wildlife resources of the watershed.

In addition to effectively maintaining those land treatment measures already established (table 1A), it is planned to establish or complete the installation of the needed land treatment measures on an additional 2,780 acres of cropland, 4,880 acres of rangeland, and 4,600 acres of pastureland (table 1) during an eight-year installation period.

With the installation of the planned land treatment, 70 percent of the watershed will be adequately treated. Adequately treated land is land used within its capability on which the conservation measures and practices that are essential to its protection and planned improvement have been applied.

Conservation land treatment applied and to be applied in this watershed will be on privately owned lands. The land user will make the decision on the use of his land and the treatment measures which he will install on his lands.

Good condition rangeland and improved pasture separately fenced to allow deferred and proper grazing.

Good stand of King Ranch bluestem established after brush control.

4-31130 12-71

Conservation measures to be applied on cropland include conservation cropping system, crop residue management, diversions, terraces, and grassed waterways or outlets in combinations necessary to provide adequate treatment. Conservation cropping systems primarily include strip cropping and crop rotation of small grain with and without legumes, grain sorghums, and forage sorghums.

Crop residue management is the use of crop residues to protect cultivated land during critical erosion periods. Stubble mulching is the managing of plant residues on a year-round bases in which harvesting, tilling, planting, and cultivating operations are performed in a manner to keep protective vegetation on the soil surface. A diversion is a channel with a supporting ridge on the lower side constructed across the slope of a field and is designed and located to protect land from erosion producing storm runoff from adjacent areas. A terrace is also a land treatment measure consisting of an earth embankment or ridge and channel constructed across the slope of the land to retard and increase infiltration of runoff and reduce erosion on the land on which it is constructed. A grassed waterway or outlet is a natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for the safe disposal of runoff from a field, diversion, or terrace.

Conservation measures which will be applied on pastureland include the planting or reseeding of adapted species of perennial or biennial forage plants and their management for long time production and use.

Rangeland which does not have plants in the desired quantity or quality will receive conservation treatment measures. These measures may consist of one or a combination of the following: brush management, range seeding, proper grazing use, deferred grazing, and the application of planned grazing systems.

Rangeland which has satisfactory forage production will be managed to maintain or improve the existing range condition.

Brush management involves the selective control of noxious woody species to reduce competition and allow the establishment of desired vegetation. Methods of control which will enhance wildlife habitat and preserve esthetic values will be encouraged. The recommended method of implementing brush management in areas having populations of wildlife will retain units and patterns of brush of good habitat value in favorable locations for use as browse and cover. Oak, elm, and pecan compose about 10 percent of the present composition on the bottomland. These species will be retained. Brush management on the upland will have about 20 percent of the woody species for wildlife cover. Range seeding is the establishment of adapted plants by seeding on rangeland. Range seeding is applicable on rangeland which cannot be improved within a reasonable period of time by grazing management practices due to the absence of a satisfactory seed source.

Proper grazing use, deferred grazing and planned grazing systems, involve the grazing of forage plants at periods of time and at intensities which are compatible with the physiological needs of the plant. Application

of these practices assures the continued growth and survival of desired plant species.

Range seeding of areas on and adjacent to the sediment pools will be encouraged to retard erosion and prevent sedimentation. The construction of additional ponds will result in reduced overgrazing and vegetative destruction around existing water facilities.

Land treatment measures that are of value and benefit to wildlife will be installed and maintained. Winter small grain and legumes will be included in the conservation cropping systems to provide winter grazing for deer.

Wildlife upland habitat management will be practiced to enhance habitat for deer, turkey, bobwhite quail, and other species. Plantings of woody and seed bearing vegetation on suitable areas such as idle or eroded lands, along fence rows, and around ponds will be encouraged. Landowners and operators will be encouraged to seek the advice of the Texas Parks and Wildlife Department and the Bureau of Sport Fisheries and Wildlife on the stocking and managing of fish in farm ponds. These measures can help contribute to supplemental farm and ranch income from the sale of hunting and fishing leases.

Landowners and operators will continue to install and maintain measures needed in the watershed following the project installation period.

To facilitate the installation of land treatment during the eight-year installation period, soil surveys will be accomplished on 12,160 acres of the watershed that are not surveyed.

A soil survey is the classification, mapping, correlation, and interpretation of various types of soils in an area. Soils are classified considering their physical, chemical, and mineralogical characteristics. The classified soils are located and outlined on a map or aerial photograph of the area being surveyed, and correlated to determine the relationship of the various soils in the area to one another and to similar or identical soils identified in other areas. Soil survey interpretations indicate the limitations and suitability of a soil for selected uses.

Structural Measures

A system of six floodwater retarding structures will be constructed in the Kickapoo Creek watershed. The locations of the floodwater retarding structures to be installed are shown on the Project Map (figure 4).

The six planned floodwater retarding structures will detain an average of 4.00 inches of runoff from 28.94 square miles of drainage area. These structures will control runoff from approximately 36 percent of the total watershed. The total storage capacity of the floodwater retarding structures is 7,692 acre-feet, of which 1,518 acre-feet are for sediment storage and 6,174 acre-feet are for floodwater retarding storage.

All structures are designed with sufficient sediment storage capacities to provide 100-year project life. All planned structures will store both

submerged and aerated sediment. Principal spillway crests of all structures will be set at the elevation of the 100-year sediment pool. The principal spillways for structures Nos. 1, 2, 3, and 4 will be ported, as required by Texas Water Rights Statutes, at the elevations which will limit impoundments to 200 acre-feet including borrow. This will provide 977 acre-feet of temporary storage capacity below the lowest ungated principal spillway openings.

All of the structures will have provisions to release impounded water in order to perform maintenance, and if it becomes necessary, to avoid encroachment upon prior downstream water rights. These provisions for floodwater retarding structure No. 2 can also be used, if needed, for the release of water to Bailey Lake.

Major factors which will affect construction of the floodwater retarding structures will be rock excavation in the emergency spillway for structure No. 5; seasonal high water tables at structures Nos. 1, 2, and 4; and zoning of available borrow material within embankments.

Emergency spillways for structures Nos. 2 and 3 will be excavated in materials having a high potential for erosion in both the control and exit channel sections. Emergency spillways for structures No. 4, 5, and 6 have a medium potential for erosion in the control and exit channel sections. Since all the emergency spillways are potentially susceptible to at least moderate erosion, additional floodwater detention capacity has been added to all floodwater retarding structures to protect the emergency spillways. These volumes of storage capacities exceed minimum requirements.

Vegetation effective in controlling erosion will be established in the emergency spillway forebay and exit channel areas and on embankment slopes. In addition, a combination of multiple use plants, including woody species, adapted to prevailing conditions will be planted on all other disturbed areas for erosion control and wildlife food and cover.

Preliminary and present indications are that principal spillways will be on compressible foundations and will have monolithic rectangular reinforced concrete inlets and prestressed concrete-lined, steel cylinder pipe outlet barrels. Rock lined plunge pools for all floodwater retarding structures are included in the preliminary details. Structural details will be treated in the final design phase.

The maximum capacity of the principal spillway for structure No. 3 is 43 cubic feet per second per square mile of drainage area (csm). This is higher than that of the other structures, which range from 15 up to 23 csm. The higher capacity for structure No. 3 was selected to prevent inundation of a cemetery at an elevation of 2.5 feet above the emergency spillway crest. The stream channel capacity below structure No. 3 is sufficient to convey the principal spillway discharge within channel banks.

Ample volumes of alluvial sandy clay, clayey sand, and silty clay, suitable for construction of the embankments, are available within short haul distances.

Foundations are characterized by deep alluvial sandy clay, silty clay, silty sand and minor amounts of silty gravel. Red shale of the Strawn Group underlies the alluvium and crops out on the major portions of abutments for structures Nos. 1, 4, 5, and 6. For structures Nos. 2 and 3, sand, clay, and soft sandstone of the Twin Mountains Formation underlie the alluvium and occur on abutments. A need for foundation drainage measures for structures Nos. 2 and 3 is anticipated. Minor foundation drainage may be needed for structures Nos. 4 and 6.

Installation of floodwater retarding structures will require change in location or modification of known existing improvements as follows:

Site No. 1 - Private roads, fences, and four livestock watering ponds

Site No. 2 - Private roads, fences, livestock watering pond, two barns, unoccupied house, two power lines, and a telephone line

Site No. 3 - Private roads, fences, waterwell, abandoned house, and a power line

Site No. 4 - Fences, six livestock watering ponds, power line, telephone line, and a county road

Site No. 5 - Private roads, fences, four livestock watering ponds, barn, and livestock pens

Site No. 6 - Private road and a livestock watering pond

All costs for necessary changes in location or modifications as listed above are land rights costs and will be borne by the sponsoring local organizations.

Under present conditions there will be no apparent displacements or relocations of persons, businesses, or farm operations as a result of installation of structural measures. If relocations or displacements become necessary, they will be carried out under the provisions of Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

Installation of the structural measures will require 909 acres of land which includes 80 acres of cropland, 159 acres of open pastureland, 161 acres of open rangeland, and 509 acres of wooded rangeland. The construction of dams and emergency spillways will require about 125 acres of which 4 acres are cropland, 35 acres are open pastureland, 42 acres are open rangeland, and 44 acres are wooded rangeland. The sediment pools at the lowest ungated outlet will inundate 148 acres of which 4 acres are cropland, 13 acres are open pastureland, 38 acres are open rangeland, and 93 acres are wooded rangeland. These pools will inundate about 4.8 miles of normally dry stream channels. The retarding and sediment reserve pools will require 636 acres of land, of which 72 acres are cropland, 111 acres are open pastureland, 81 acres are open rangeland, 372 acres are wooded rangeland, for temporary impoundment of floodwater.

Preliminary investigations indicate all needed materials for the dams can probably be obtained from required excavation in the emergency spillway areas and from designated borrow areas within the sediment pools.

Approximately 137 acres will be cleared of all existing woody vegetation for the construction of dams, emergency spillways, and sediment pools below the lowest ungated outlet. Native grasses will be disturbed as little as possible. This vegetation consists of various species and approximate acreages as follows:

Forty-four acres have scattered post oak (Quercus stellata), mesquite (Prosopis juliflora), elm (Ulmus spp.), skunkbush sumac (Rhus aromatica), greenbrier (Smilax spp.), lotebush (Condalia obtusifolia), tasajillo (Opuntia leptocaulis), and willow (Salix nigra) with an average height of less than five feet.

Thirty-eight acres have an overstory of cedar elm (Ulmus crassifolia), post oak, bumelia (Bumelia lanuginosa), and live oak (Quercus virginiana), with a canopy of about 70 percent. Basal area of overstory species ranges between 60 and 120 square feet. The average diameter is 6 inches and ranges between 3 and 16 inches. Understory species include greenbrier, virginia creeper (Parthenocissus quinquefolia), grape (Vitus spp.), skunkbush, bumelia, elbowbush (Forestieria pubescens), redberry juniper (Juniperus pinchoti), elm, post oak, and hackberry (Celtis laevigata).

Twenty-six acres have an overstory of post oak and cedar elm with a canopy of 35 percent. Basal area of the overstory is about 20 square feet. The average diameter is 6 inches ranging from 3 to 11 inches. Understory species include scattered mesquite, prickly pear (Opuntia spp.), bumelia, greenbrier, and hawthorn (Crataegus spp.).

Fifteen acres of the woody vegetation have an overstory of bumelia, post oak, elm, and scattered Texas oak (Quercus shumardii var. Texana), live oak, and cottonwood (Populus deltoides), with a canopy of about 60 percent. Basal area is between 60 and 70 square feet. The average diameter of overstory species is about 10 inches and ranges from 5 to 17 inches. Understory species include greenbrier, bumelia, dogwood (Cornus drummondii), indigobush (Amorpha fruticosa), skunkbush sumac, blackhaw (Viburnum rufidulum), grape, mesquite, and hawthorn.

Twelve acres have an overstory of cedar elm, slippery elm, (Ulmus rubra), cottonwood, pecan (Carya illinoensis), Texas oak, and live oak, with a canopy of about 60 percent. Basal area of overstory species is about 60 square feet. Average diameter is about 13 inches ranging from 6 to 30 inches. One cottonwood, which is atypical of the rest measured 49 inches in diameter. Understory vegetation includes hackberry, blackhaw, dogwood, wild plum (Prunus spp.), elbowbush, carolina buckthorn (Rhamnus caroliniana), bumelia, greenbrier, grape, poison-ivy (Rhus toxicodendron), redberry juniper, and virginia creeper.

There are two acres of fence rows which have pecan and western soapberry (Sapindus drummondii) with an average diameter of about 10 inches.

Vegetation effective in controlling erosion will be established in areas where vegetation is destroyed during construction and not inundated by the impoundments in the sediment pools. Also, woody vegetation adapted to prevailing conditions will be planted and maintained in conjunction with erosion control on disturbed areas above and below the embankments.

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the works of improvement; to provide for flowage of water in, upon, or through the structures; and provide for the permanent storage and temporary detention, either or both, of any sediment or water.

The environment will be protected from soil erosion and water and air pollution during construction. Contractors will be required to adhere to strict guidelines set forth in each construction contract to minimize soil erosion and water and air pollution during construction. Excavation and construction operations will be scheduled and controlled to prevent exposure of extraneous amounts of unprotected soil to erosion and the resulting translocation of sediments. Measures to control erosion will be uniquely specified at each work site and will include, as applicable, use of temporary vegetation, mulches, diversions, mechanical retardation of runoff, and traps. Harmful dust and other pollutants inherent to the construction process will be held to minimum practical limits. Haul roads and excavation areas, and other work sites will be sprinkled with water as needed to keep dust within tolerable limits. Contract specifications will require that fuel, lubricants, and chemicals be adequately labeled and stored safely in protected areas, and disposal at work sites will be by approved methods and procedures. Clearing and disposal of brush and vegetation will be carried out in accordance with applicable laws, ordinances, and regulations in respect to burning. Each contract will set forth specific stipulations to prevent uncontrolled grass or brush fires. Disposal of brush and vegetation will be by burying, hauling to approved off-site locations, or controlled burning, as applicable.

Stringent requirements for safety and health in conformance with the Construction Safety Act will be included in each construction contract.

Necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such faciiities being a pollution hazard to live streams, wells, or springs in conformance with federal, state, and local water pollution control regulations. Conformance to all environmental control requirements will be monitored constantly by a construction inspector who will be on-site during all periods of construction operation.

The six floodwater retarding structures are scheduled to be constructed during six years of the eight-year installation period. It is not anticipated that construction work on more than two floodwater retarding structures will be underway at the same time. This will minimize cumulative environmental effects resulting from construction activities.

The environment will continue to be protected from erosion and water pollution following completion of construction. Project sponsors will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution. Sponsors have given assurance that adequate sanitary facilities meeting local and state health standards will be provided if the impoundments in the sediment pools are used for recreational purposes.

Figure 2 shows a section of a typical floodwater retarding structure. Figures 3 and 3A include a general plan of a dam, emergency spillway, and reservoir; an embankment plan and profile; and a cross section of a zoned embankment typical of the type of floodwater retarding structure included in this work plan. Table 3 shows details on quantities and design features for each floodwater retarding structure.

All applicable state laws will be complied with in the design and construction of the structural measures as well as those pertaining to the storage, maintenance of quality, and use of water.

The watershed work plan has been coordinated with the Texas State Historical Commission and the National Park Service, USDI. An archeology survey of the floodwater retarding sites was conducted by the Department of Anthropology, Archeology Research Program, Southern Methodist University, under the direction of Mr. S. Alan Skinner as principal investigator. Four archeological sites were observed within the areas required for the construction and functioning of the floodwater retarding structures Nos. 2, 3, and 4. Archeological sites were not located on the areas needed for floodwater retarding stuuctures Nos. 1, 5, and 6. Due to the eroded condition of the sites observed, no additional archeological survey work is recommended by Mr. Skinner.

However, if evidence of significant archeological features are observed before or during construction, the Secretary of the Interior will be notified so he may have investigations carried out to evaluate and salvage, if warranted, the resources. This will be done in compliance with Public Law 86-523.

EXPLANATION OF INSTALLATION COSTS

Public Law 566 funds, in the amount of about $51,900 for technical assistance during the eight-year installation period, will be provided to accelerate the application of the planned land treatment for watershed protection. This amount includes about $2,300 for completion of soil surveys. These Public Law 566 funds will be in addition to about $48,700 of Public Law 46 funds provided under the going program. It is expected that 35 new conservation plans and about 100 conservation plan revisions will be realized during the installation period. Soil surveys will be accomplished on 12,290 acres. Watershed landownership and ownership patterns are experiencing numerous changes, and it is imperative that new conservation plans and revisions be made and applied to accomplish the projected goals. Local interests will apply the planned land treatment at an estimated cost of $360,700, which includes expected reimbursements

from the Great Plains Conservation Program of the Soil Conservation Service. The costs of application of the various measures are based on present prices being paid by landowners and operators in the area.

The total installation cost of the structural measures is estimated to be $912,120 of which $802,690 will be borne by Public Law 566 funds and $109,430 by local interests.

The Public Law 566 costs for project installation includes $654,550 for construction, $39,790 for engineering services, and $108,350 for project administration.

The local costs for project installation include $93,780 for the value of land; $10,400 for change in location or modification of utility lines, private roads, buildings, county roads, and fences; $2,350 for legal fees; and $2,900 for project administration.

Construction costs include the engineer's estimate and contingencies. The engineer's estimate was based on unit costs of structural measures in similar areas modified by special conditions inherent to the site locations. Included are such items as permeable foundations, special placement of embankment materials, and rock excavation in one emergency spillway. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs.

Engineering services and project administration costs were based on an analysis of previous work in similar areas. Engineering services costs consist of, but are not limited to, detailed surveys, geologic investigations, laboratory analysis, reports, designs, and cartographic services.

Public Law 566 project administration costs consist of construction inspection, contract administration, and maintenance of Soil Conservation Service records and accounts.

The local costs for project administration includes sponsors' costs related to contract administration, overhead and organizational administrative costs, and whatever construction inspection they desire to make at their own expense.

The value of land rights was determined by appraisal in cooperation with representatives of the sponsoring local organizations.

4-31130 11-73

The following is the estimated schedule of obligations for the eight-year installation period.

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	6,480	51,170	57,650
Second	Land Treatment	6,490	51,180	57,670
	Structure No. 2	257,410	28,830	286,240
Third	Land Treatment	6,490	51,170	57,660
	Structure No. 1	124,470	20,800	145,270
Fourth	Land Treatment	6,490	51,180	57,670
	Structure No. 3	128,760	16,550	145,310
Fifth	Land Treatment	6,490	51,170	57,660
	Structure No. 4	139,450	22,600	162,050
Sixth	Land Treatment	6,490	51,180	57,670
	Structure No. 5	93,970	12,900	106,870
Seventh	Land Treatment	6,490	51,170	57,660
	Structure No. 6	58,630	7,750	66,380
Eighth	Land Treatment	6,480	51,180	57,660
	Total	854,590	518,830	1,373,420

This schedule may be changed from year to year to conform with appropriations, accomplishments, and any mutually desirable changes.

EFFECTS OF WORKS OF IMPROVEMENT

Flood Prevention, Erosion and Sediment

The installation of the project measures, both land treatment and structural measures, will achieve the project objectives of watershed protection and flood prevention.

The application of the planned land treatment measures will improve the productivity of the soil by reducing erosion and improving the fertility and infiltration properties of the soil. The measures will also reduce downstream floodwater and sediment damages by reducing erosion and the peak rate of runoff from the upland. On cropland, the establishment of conservation cropping systems will encourage diversification of type of crops grown which will provide increased year-round cover and food sources for game birds and waterfowl. Rangeland treatment measures include brush

control for the selective removal of undesirable brush on over-used grassland areas and grazing management practices which increase ground cover, productivity, and density of grasses and other palatable forb plants normally found in the plant community. This would increase the desirability of the habitat for deer, quail, and turkey, and decrease the habitat for squirrel, raccoon, and some song birds. Ponds installed for watering of livestock will also provide watering spots for wildlife and provide additional potential for developing fisheries.

Owners and operators of flood plain land will be able to improve their management of flood plain lands, due to reduced flooding, by proper fertilization and other management practices necessary to reach optimum use of flood plain land. Management on approximately 1,120 acres of unimproved grassland on the flood plain will be intensified. Approximately 770 acres of this area are in brushy and woody vegetation and will be cleared to increase hay and coastal bermudagrass plantings. This clearing will reduce habitat for wildlife requiring woody and brushy vegetation. Improved pastureland and hayland will provide a more dependable feed source for livestock and reduce the expenditures required for the purchase of feed. It is not expected that any of the flood plain land will be shifted from pastureland to cropland, nor is it expected that the project will result in any increase in acreage of crops in surplus supply. The annual application of up to 280 additional tons of fertilizer will not have a significant impact on the quality of impounded water within the watershed. It is anticipated that the additional fertilizer will be applied to improve pastureland and hayland in the flood plain area. With the establishment of vegetation such as bermudagrass and construction of the floodwater retarding structures, this area will be subject to less erosion and flooding. With reduced erosion and flooding, fertilizer residues will have less opportunity to be adsorbed on suspended sediment or moved in solution in floodwater.

Application of the planned land treatment is expected to reduce annual gross erosion from 175,300 tons to 156,000 tons, a reduction of approximately 11 percent. Annual flood plain scour damage on 889 acres is expected to be reduced about 68 percent.

When the project is complete, a 66 percent reduction in overbank sediment deposition damage on 402 acres will be effected. Sediment transported in suspension is the major pollutant in the watershed's streams. It is estimated that the concentration of suspended sediment leaving the watershed in average annual surface runoff will be reduced from 1,800 to 1,200 parts per million as a result of the combined program of land treatment and floodwater retarding structures.

Sediment originating in the watershed and deposited in Lake Granbury will be reduced by an average of 12 acre-feet annually, a 36 percent reduction. Bailey Lake, the present water supply for the town of Lipan, will have a prolonged life due to an 80 percent sediment reduction, which will amount to an average of four acre-feet annually.

The project will provide protection to 2,960 acres of flood plain within the watershed and will benefit directly the owners and operators of

approximately 50 farms and ranches in the flood plain. In addition, the owners and operators of the flood plain land along the Brazos River below Kickapoo Creek will receive some benefits from the project. Indirect damage reduction benefits will also accrue to the project. These benefits include the reduction or elimination of expenses associated with interruption or delay of travel, rerouting of school busses and mail routes, disruption of farm operations, business losses in the area and similar losses.

Average annual flooding will be reduced from 1,203 acres to 423 acres, a reduction of 65 percent. Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas to be benefited as a result of reduced flooding, caused by the combined program of land treatment and the structural measures, is presented in the following tabulation:

Average Annual Area Inundated

Evaluation Reach (Figure 1)	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
1	Confluence of Brazos River to VS-K-7	740	320	57
2	VS-K-7 to Structures	463	103	78
	Total	1,203	423	65

The number of acres inundated in each evaluation reach without and with the project by various frequency floods is presented in the following tabulation:

Area Inundated by Selected Recurrence Intervals

Evaluation Reach (Figure 1)	Average Recurrence Interval							
	2-Year		5-Year		25-Year		100-Year	
	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)
1	515	90	1,244	606	1,658	1,260	1,833	1,567
2	326	0	801	134	1,017	509	1,127	657
Total	841	90	2,045	740	2,675	1,769	2,960	2,224

Had the project been installed at the time of the April 27-28, 1957 flood, acres flooded would have been reduced from about 2,675 acres to 1,769 acres, a reduction of approximately 30 percent. Monetary damages would have been reduced from an estimated $104,430 to $42,220, a reduction of 60 percent.

The following tabulation shows effects of the project on flood damages by evaluation reaches. All figures indicate average annual reductions:

	Damage Reduction in Percent					
Evaluation Reach (Figure 1)	Crop and Pasture	Other Agricultural	Non-Agricultural	Overbank Sediment	Flood Plain Erosion	Total
1	60	68	68	60	62	64
2	84	90	90	77	80	86
Weighted Average	69	77	80	66	68	73

A maximum initial reduction in average annual runoff of 250 acre-feet is expected from the effects of evaporation from the sediment pools of the floodwater retarding structures. This will result in an initial reduction from 11,320 acre-feet to 11,070 acre-feet, or 2.2 percent, in average annual volume of watershed runoff. This initial water loss will be reduced as sediment accumulates in the sediment pools over the life of the project. The reduction of average annual streamflow into Lake Granbury will be less than 0.02 percent. The quality of runoff from Kickapoo Creek is good and serves to dilute the more saline water of the Brazos River. The minor reduction in runoff is not expected to have a significant effect on the water quality of the Brazos River. Evaporation losses from 200 acre-feet of water impounded in the sediment pool of floodwater retarding structure No. 2 will decrease 1,460 acre-feet of average annual runoff to Bailey Lake to 1,378 acre-feet, a reduction of 82 acre-feet or about six percent. The floodwater retarding structure will have appurtenances to release water from the sediment pool to honor downstream water rights as necessary.

During construction of the structural works of improvement, air and water pollution will increase slightly from dust and sediment inherent to the construction process. This increase will be kept within tolerable limits. After installation and with the establishment of vegetation for erosion control, pollution from these sources is expected to be at or below pre-construction levels.

Fish and Wildlife and Recreation

The effects of the works of improvement on fish and wildlife habitat are described by the Bureau of Sport Fisheries and Wildlife as follows:

"With the project, the land treatment measures and floodwater retarding structures would reduce the amount of sediment reaching the Brazos River and DeCordova Bend Reservoir (Lake Granbury), thus improving downstream

fish habitat. The floodwater retarding reservoirs would provide more sport fishing in the watershed.

No commercial fishing is expected to develop with the project.

With the project, the structural measures and most land treatment measures generally would aid wildlife. The floodwater retarding reservoirs and farm ponds would provide some resting areas for waterfowl. Land treatment measures such as conservation cropping systems, proper grazing use, and deferred grazing would be beneficial to deer and upland game. Stirring of the soils would stimulate weed growth and thus benefit seed-eating animals. However, increasing the density of grass cover in the project area would decrease the food supply for dove and bobwhite quail. Indiscriminate brush control could be damaging to wildlife habitat in the watershed."

The water area in sediment pools at the elevations of the lowest ungated outlets will create 148 acres of additional lake fisheries, waterfowl resting places, and water for wildlife. This area will be lost as wildlife habitat. The inundation of 4.8 miles of normally dry stream channels will have no significant effect on stream fisheries. Presently the only fisheries associated with stream channels that will be inundated is a scoured out channel area in the pool of floodwater retarding structure No. 2 and a small stock pond located on a tributary channel in floodwater retarding structure No. 1.

The construction of dams and emergency spillway areas will temporarily destroy the wildlife habitat value of 125 acres of which 35 acres are pastureland, 42 acres are open rangeland, 44 acres are wooded rangeland, and the remaining 4 acres are cropland. However, dams and spillways will be revegetated immediately with multiple-use plants having value to wildlife.

The vegetative cover and wildlife habitat value of the 636 acres in the floodwater retarding pools will undergo no significant change in composition as a result of project action. However, an increase in growth and density of most existing species is anticipated because of increased moisture resulting from periodic inundation.

The sediment pools of the six floodwater retarding structures will initially impound 977 acre-feet of water below the lowest ungated outlets. It is anticipated that removal of earth fill materials from the sediment pools for the dams will create 238 acre-feet of the total 977 acre-foot capacity. Due to the expected design of the principal spillways and the uncertainty of the exact locations where these materials will be obtained within the sediment pools, it is anticipated that 238 acre-feet of water will not be available for downstream release. A maximum of 739 acre-feet of water available for streamflow augmentation would provide a very limited duration and volume of streamflow. During drought periods, the release of water from the sediment pools would have a negligible effect on streamflow in Kickapoo Creek.

Archeological, Historic, and Scientific

Presently there are no known historical or significant archeological locations or artifacts that will be effected by the project. The Department of Anthropology, Archeology Research Program, Southern Methodist University, conducted detailed field surveys on the floodwater retarding sites and recommended further investigations were unwarranted.

Economic and Social

The application of the planned land treatment program will result in more efficient use of cropland and grassland which will increase farm and ranch income.

Secondary benefits to the local area resulting from the project will include the additional requirements for about 280 tons of fertilizer, as well as additional seed, petroleum products, repair services, and some new haying equipment annually. New fencing will be required for proper management of pastures and hay meadows.

Increased agricultural efficiency will be realized by the operators of land that will become productive after damaging floods and sediment deposition have been alleviated. The reduction of damages by structural means will provide an impetus for a higher quality of living and social upgrading by watershed residents. The increased needs of the entire economy will create the equivalent of 11 permanent jobs for local residents.

During the construction stage of the proposed project, additional requirements for building materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 32 man-years of employment, which will further strengthen the economy during the construction phase. The operation and maintenance of project measures will also provide employment for local residents.

Additional intangible benefits will accrue to the project allowing an opportunity for the shifting of public funds for the repair of damages to county roads and bridges to investment in schools and improving existing roads. Likewise private funds now going to repair of flood damage could be shifted to raising the standard of living of the residents in the affected area.

Other

The installation of floodwater retarding structures will require the commitment of a total of 909 acres of agricultural lands to project purposes. Of this acreage, 80 acres are cropland, 159 acres are pastureland, 161 acres are open rangeland, and 509 acres are wooded rangeland. A total of 273 acres required for dams, spillways, and sediment pools will be retired from agricultural production. Land use of the area to be retired is 8 acres of cropland, 48 acres of pastureland, 80 acres of open rangeland, and 137 acres of wooded rangeland.

The sediment pools of the floodwater retarding structures will provide a more dependable water supply for livestock.

There are no areas such as feedlots in the watershed with large concentrations of livestock. Livestock within the drainage areas of the floodwater retarding structures are on pastureland and rangeland. Long-time observations at floodwater retarding structures constructed on the same or similar soils and having comparable conditions in their drainage areas have not evidenced a significant degree of fouling of water in the sediment pools by livestock. Therefore, appreciable contamination from livestock to water in the sediment pools is not anticipated.

The safety hazard at low water crossings will be reduced and some of these low water crossings will be replaced by bridges.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, erosion, and indirect damages within the watershed will be reduced from $49,410 to $13,610. This is a reduction of 72 percent. Including sediment damage in Lake Granbury (table 5), the damage will be reduced from $53,240 to $16,050, a reduction of 70 percent.

Benefits from the planned land treatment measures other than floodwater, sediment, and scour damage reduction benefits were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

Reduction in monetary flood damages vary with respect to locations within the watershed. The following tabulations show the general locations of average annual damage reductions and benefits attributed to the combined program of land treatment and structural measures.

Average Annual Damages and Benefits

Evaluation Reach (figure 1)	Location	Damages Without Project (dollars)	Damages With Project (dollars)	Reduction (percent)	Benefits (dollars)
1	Confluence of Brazos River to VS-K-7	28,580	10,500	63	18,080
2	From VS-K-7 to Structures	20,830	3,110	85	17,720
-	Lake Granbury (Sediment)	3,830	2,440	36	1,390
Total		53,240	16,050	70	37,190

Direct Monetary Floodwater Damages

Evaluation Reach (figure 1)	Average Recurrence Interval: 2-Year Without Project (dollars)	2-Year With Project (dollars)	10-Year Without Project (dollars)	10-Year With Project (dollars)	25-Year Without Project (dollars)	25-Year With Project (dollars)	100-Year Without Project (dollars)	100-Year With Project (dollars)
1	7,410	1,100	43,960	18,900	60,810	29,980	81,110	50,740
2	5,090	-	34,080	5,050	43,620	12,240	69,660	22,910
Total	12,500	1,100	78,040	24,040	104,430	42,220	150,770	73,650

Annual net income will increase an estimated $22,630 annually to owners and operators of the flood plain land from more intensive land use.

Incidental livestock water benefits from use of the sediment pools of the floodwater retarding structures are estimated at $2,140 annually. In addition, these pools will also provide watering places for wildlife.

It is estimated that the project will produce local secondary benefits, which exclude indirect benefits in any form, averaging $56,290 annually. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Erath, Hood, Parker, and Palo Pinto Counties have not been designated as areas eligible for assistance under the Economic Development Act. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of the structural measures (amortized total installation and project administration costs, plus operation and maintenance) is $52,710. These measures are expected to produce total average annual benefits of $115,550 resulting in a benefit cost ratio of 2.2:1.0 (table 6).

The ratio of total average annual benefits, excluding secondary benefits, accruing to structural measures ($59,260) to the average annual cost of structural measures ($52,710) is 1.1:1.0.

PROJECT INSTALLATION

Landowners and operators will establish planned land treatment (table 1) in cooperation with the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts during an eight-year period. Technical assistance in planning and application of land treatment will be provided under the going program of the districts in addition to accelerated assistance under Public Law 566. Soil surveys have been made on about 40,000 acres and will be accomplished on the remaining watershed area.

An estimated 45 percent of needed soil and water conservation practices have been applied. The goal is to increase the level of land treatment

application to at least 70 percent of total needs during the installation period. In reaching this goal, it is expected that accomplishments of the additional treatment will progress as shown in the following tabulation:

Land Use	Fiscal Year 1st (acres)	2nd (acres)	3rd (acres)	4th (acres)	5th (acres)
Cropland	340	350	350	350	350
Pastureland	570	570	580	580	580
Rangeland	610	610	610	610	610
Total	1,520	1,530	1,540	1,540	1,540

Land Use	Fiscal Year - Continued 6th (acres)	7th (acres)	8th (acres)	Total (acres)
Cropland	350	350	340	2,780
Pastureland	580	570	570	4,600
Rangeland	610	610	610	4,880
Total	1,540	1,530	1,520	12,260

The governing bodies of the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts will assume aggressive leadership in getting the land treatment program underway. Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. In addition, landowners and operators where floodwater retarding structures will be located will be encouraged to apply and maintain measures for the enhancement of wildlife. The Soil Conservation Service will provide technical assistance in the planning and application of soil, plant, and water conservation measures.

Special emphasis will first be placed on getting a higher degree of land treatment in the drainage areas of floodwater retarding structures. Then the emphasis will be on drainage areas not controlled by structures.

The Extension Service will assist with the educational phase of the program by providing information to landowners and operators in the watershed.

The Erath, Hood, Palo Pinto, and Parker County Commisiioners Courts have rights of eminent domain under applicable state law and have the financial resources to fulfill their responsibilities.

The Soil Conservation Service, in compliance with a request from the sponsors, will provide the necessary administrative and clerical personnel; facilities, supplies, and equipment to advertise, award, and administer contracts; and will be the contracting agency to let and service contracts. The Erath, Hood, and Parker County Commissioners Courts will represent

sponsoring local organizations in coordination with the Soil Conservation Service on matters concerning construction in their respective counties.

The Erath County Commissioners Court will have the following responsibilities pertaining to the planned floodwater retarding structures Nos. 1 and 2:

1. Obtain the necessary land rights;

2. Provide for the change in location or modification of utility lines and systems, private roads, and other privately owned improvements necessary for installation of the floodwater retarding structures;

3. Provide for the necessary improvements to low water crossings on public and private roads within the boundaries of Kickapoo Creek watershed and within Erath County to make them passable during prolonged release flows from the floodwater retarding structures or provide equal alternate routes for use during periods of inundation;

4. Determine and certify legal adequacy of easements and permits for construction of structural measures; and

5. Relocate the county road affected by the embankment and detention pool of floodwater retarding structure No. 2. This will be done through a court order and at no expense to the federal government.

The Hood County Commissioners Court will have the following responsibilities pertaining to planned floodwater retarding structures Nos. 3, 4, and 5:

1. Obtain the necessary land rights;

2. Provide for the change in location or modification of utility lines and systems, private roads, and other privately owned improvements necessary for installation of the floodwater retarding structures;

3. Provide for the necessary improvements to low water crossings on public and private roads within the boundaries of Kickapoo Creek watershed and within Hood County to make them passable during prolonged release flows from the floodwater retarding structures or provide equal alternate routes for use during periods of inundation;

4. Determine and certify legal adequacy of easements and permits for construction of structural measures; and

5. Close the county road affected by the embankment, detention pool, and emergency spillway of floodwater retarding structure No. 4, and provide an equal or alternate route. This will be done through a court order and at no expense to the federal government.

The Parker County Commissioners Court will have the following responsibilities pertaining to planned floodwater retarding structure No. 6:

1. Obtain the necessary land rights;

2. Provide for change in location of private roads and other privately owned improvements necessary for the installation of the floodwater retarding structure;

3. Provide for the necessary improvements to low water crossings on public and private roads within the boundaries of Kickapoo Creek watershed and within Parker County to make them passable during prolonged release flows from the floodwater retarding structure or provide equal alternate routes for use during periods of inundation; and

4. Determine and certify legal adequacy of easements and permits for construction of structural measures.

Technical assistance will be provided by the Soil Conservation Service in preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install the planned structural measures.

The six floodwater retarding structures will be constructed during the second, third, fourth, fifth, sixth, and seventh years of an eight-year project installation period in the general sequence as follows:

Second Year - Floodwater Retarding Structure No. 2
Third Year - Floodwater Retarding Structure No. 1
Fourth Year - Floodwater Retarding Structure No. 3
Fifth Year - Floodwater Retarding Structure No. 4
Sixth Year - Floodwater Retarding Structure No. 5
Seventh Year - Floodwater Retarding Structure No. 6

In order for construction to proceed according to schedule, all land rights for floodwater retarding structures are scheduled to be secured by the end of the time periods as shown in the following tabulation. The schedule will begin when the work plan is approved for operations.

Time Period	Floodwater Retarding Structures
First six months	Nos. 1, 2 and 3
Second six months	Nos. 4 and 5
Third six months	No. 6

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out works of improvement described in this work plan will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666).

The cost of applying land treatment measures will be borne by landowners and operators. Funds provided under the going program (Public Law 46) and Public Law 566 funds will be used for technical assistance in planning and applying soil and water conservation measures. The Public Law 566 funds will be used for the acceleration of planning and application of these measures.

Funds for the local share of the cost of this project relative to structural measures will be provided by Erath County for floodwater retarding structures Nos. 1 and 2; Hood County for floodwater retarding structures Nos. 3, 4, and 5; and Parker County for floodwater retarding structure No. 6. The Commissioners Courts of Erath, Hood, and Parker Counties have the financial ability to make arrangements to carry out their responsibilities. They will set aside funds to finance their respective local share of the installation costs of the planned six floodwater retarding structures.

It is anticipated that approximately 80 percent of the easements for structural measures will be donated. Out-of-pocket costs for land rights, legal expenses, and project administration are estimated to be $35,000.

The structural measures will be constructed during six years of an eight-year project installation period pursuant to the following conditions:

1. Requirements for land treatment in drainage areas of floodwater retarding structures have been satisfied.

2. All land rights have been obtained for all structural measures, or a written statement is furnished by the Commissioners Courts of Erath, Hood, and Parker Counties that their rights of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for purchasing those easements and rights-of-way.

3. The Erath County Commissioners Court has provided for the change in location of the county road affected by the embankment and detention pool area of floodwater retarding structure No. 2 The change in location will be through a court order and at no expense to the federal government.

4. The Hood County Commissioners Court has provided for the closing of the county road affected by the embankment, detention pool and emergency spillway of floodwater retarding structure No. 4 and designated an alternate route. The closing of the present road and designation of an alternate route will be through a court order and at no expense to the federal government.

5. Utilities such as power lines and telephone lines have been relocated or permission has been obtained to inundate the properties involved.

6. Project agreements have been executed.

7. Operation and maintenance agreements have been executed.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent upon the appropriation of funds for this purpose.

Various features of cooperation between the cooperating parties have been covered in appropriate memorandums of understanding and working agreements.

The soil and water conservation loan program sponsored by the Farmers Home Administration is available to eligible farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies to outline available services and eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

The appropriate County Agricultural Stabilization and Conservation Committees will cooperate with the governing bodies of the soil and water conservation districts by continuing to provide financial assistance for selected conservation practices.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Planned land treatment measures will be maintained by landowners and operators of farms and ranches on which measures are applied under agreement with the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of land treatment to determine maintenance needs and encourage landowners and operators to perform maintenance.

Structural Measures

The Commissioners Court of Erath County will be responsible for operation and maintenance of floodwater retarding structures Nos. 1 and 2. The Commissioners Court of Hood County will be responsible for the operation and maintenance of floodwater retarding structures Nos. 3, 4, and 5. The Commissioners Court of Parker County will be responsible for the operation and maintenance of floodwater retarding structure No. 6. Funds for this purpose will come from the general fund of the county in which the structures are located. The general fund of each county is supported by existing taxes and is available and adequate for this purpose.

The estimated average annual cost of operation and maintenance of the six floodwater retarding structures is $1,190, of which $490 is for structures in Erath County, $550 is for structures in Hood County, and $150 is for the structure in Parker County.

Project sponsors will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement for each floodwater retarding structure. The operations and maintenance agreement will be executed prior to signing a project agreement for the

construction of any of the six floodwater retarding structures. A specific operation and maintenance plan will be prepared for each structural measure. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution.

Floodwater retarding structures will be inspected at least annually and after each heavy rain by representatives of the Erath, Hood, and Parker County Commissioners Courts and the Bosque, Hood-Parker, and Palo Pinto Soil and Water Conservation Districts. A Soil Conservation Service representative will participate in these inspections for a period of at least three years following construction. The Soil Conservation Service will participate in inspections as often as it elects to do so after the third year. Items of inspection will include, but are not limited to, conditions of principal spillways and their appurtenances, emergency spillways, and earth fills. A written report will be made of each inspection. A copy of each report will be provided by the responsible organization or organizations to each other organization having operation and maintenance responsibilities and to the designated Service representative within ten days of the date on which the inspection was made.

The appropriate counties will be responsible for and perform promptly, or have performed, without cost to the Service, all maintenance of the structural measures as determined to be needed by either the sponsors or the Service immediately following completion of the structures by the contractor. The counties will be responsible for maintenance associated with structural measures after the vegetation is satisfactorily completed, as determined by the Service, but not later than three years following completion of each structural measure.

The Soil Conservation Service, through the Soil and Water Conservation Districts, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for unrestricted access by representatives of sponsoring local organizations and the Soil Conservation Service to inspect all structural measures and their appurtenances at any time and for sponsoring local organizations to operate and maintain them. Easements insuring this unrestricted ingress and egress will be furnished by the sponsoring local organizations.

Sponsors will control the handling, storage, and application of herbicides and pesticides that may be necessary for operation and maintenance of structural works of improvement. Approved reagents and compounds will be used. Their application will be compatible with current laws regulating their use. In addition to sound and prudent judgment, ordinances and standards concerned with the disposal or storage of unused chemicals, empty containers, contaminated paraphernalia, etc., will be observed and applied.

4 31130 11-73

The Erath, Hood, and Parker County Commissioners Courts will maintain a record of all maintenance inspections made, maintenance performed, and cost of such maintenance and have it available for inspection by Soil Conservation Service personnel.

The necessary maintenance work will be accomplished by contracts, force accounts, or equipment owned by sponsoring local organizations.

4-31130 11-73

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Kickapoo Creek Watershed, Texas

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ Public Law 566 Funds Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	2,780	-	38,640	38,640
Pasture	Acre	4,600	-	191,860	191,860
Rangeland	Acre	4,880	-	130,200	130,200
Technical Assistance			51,900	48,700	100,600
TOTAL LAND TREATMENT			51,900	409,400	461,300
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	6	654,550	-	654,550
Subtotal-Construction			654,550	-	654,550
Engineering Services					
Soil Conservation Service					
Floodwater Retarding Structures	No.	6	39,790	-	39,790
Project Administration					
Construction Inspection			51,170	600	51,770
Other			57,180	2,300	59,480
Subtotal-Administration			108,350	2,900	111,250
Other Costs					
Land Rights			-	106,530	106,530
Subtotal - Other			-	106,530	106,530
TOTAL STRUCTURAL MEASURES			802,690	109,430	912,120
TOTAL PROJECT			854,590	518,830	1,373,420

1/ Price Base: 1973

July 1973

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan development)

Kickapoo Creek Watershed, Texas

Measures	Unit	Number Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping Systems	Acre	4,515	45,200
Diversions	Foot	53,936	6,500
Terraces	Foot	245,912	25,000
Pasture and Hayland Planting	Acre	3,366	101,000
Pasture and Hayland Management	Acre	3,019	30,200
Proper Grazing Use	Acre	16,142	32,300
Brush Control	Acre	7,806	117,100
Range Seeding	Acre	1,576	23,600
Ponds	No.	141	84,600
Wildlife Upland Habitat Management	Acre	2,000	8,000
TOTAL			473,500

1/ Price Base: 1973

July 1973

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Kickapoo Creek Watershed, Texas
(Dollars) 1/

Item	Installation Cost P. L. 566 Funds			Installation Cost Other Funds		Total Installation Cost
	Construction	Engineering	Total P. L. 566	Land Rights	Total Other	
Floodwater Retarding Structures						
1	99,650	6,980	106,630	20,300	20,300	126,930
2	215,380	10,770	226,150	28,230	28,230	254,380
3	104,910	6,290	111,200	16,050	16,050	127,250
4	113,610	6,820	120,430	22,100	22,100	142,530
5	75,240	5,270	80,510	12,400	12,400	92,910
6	45,760	3,660	49,420	7,450	7,450	56,870
Subtotal	654,550	39,790	694,340	106,530	106,530	800,870
Project Administration			108,350		2,900	111,250
GRAND TOTAL	654,550	39,790	802,690	106,530 2/	109,430	912,120

1/ Price Base: 1973

2/ Includes $2,350 for legal fees and $10,400 for relocation or modification of fixed improvements and utilities.

July 1973

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Kickapoo Creek Watershed, Texas

Item	Unit	Structure Number 1	2	3	4	5	6	Total
Class of Structure		A	A	A	A	A	A	xx
Drainage Area (Total)	Sq.Mi.	4.02	10.67	4.03	4.48	3.08	2.66	28.94
Curve No. (1-day)(AMC II)		77	77	78	77	77	77	xxx
T_c	Hrs.	1.39	2.51	1.83	1.52	1.28	1.07	xxx
Elevation Top of Dam	Ft.	962.4	975.3	947.8	861.4	896.4	823.6	xxx
Elevation Crest Emergency Spillway	Ft.	958.3	970.0	943.8	856.3	892.6	819.9	xxx
Elevation Crest Principal Spillway	Ft.	945.3	955.9	931.2	843.5	880.4	807.7	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	944.8	949.4	930.2	839.9	880.4	807.7	xxx
Maximum Height of Dam	Ft.	36	44	40	41	31	28	xxx
Volume of Fill	Cu.Yd.	162,900	307,800	129,400	192,000	65,200	34,300	891,600
Total Capacity 1/	Ac.Ft.	1,131	2,880	937	1,244	822	678	7,692
Sediment (100 yr.)	Ac.Ft.	204	637	206	275	117	79	1,518
Sediment Submerged	Ac.Ft.	172	586	189	251	105	72	1,375
Sediment Aerated	Ac.Ft.	32	51	17	24	12	7	143
Sediment Pool (Lowest Ungated Outlet) 2/	Ac.Ft.	200	200	200	200	105	72	977
Retarding Pool	Ac.Ft.	927	2,243	731	969	705	599	6,174
Surface Area								
Sediment Pool (Lowest Ungated Outlet)	Acres	29	22	28	23	28	18	148
Sediment Pool-Principal Spillway Crest	Acres	31	81	31	39	28	18	228
Retarding Pool	Acres	135	247	98	120	95	89	784
Principal Spillway Design								
Rainfall Volume (areal)(1-day)	In.	7.95	7.99	7.50	7.62	8.00	7.95	xxx
Rainfall Volume (areal)(10-day)	In.	12.80	12.99	12.20	12.45	13.00	12.90	xxx
Runoff Volume (10-day)	In.	6.71	6.28	6.41	6.40	6.97	6.98	xxx
Capacity (Maximum)	Cfs	64	175	173	67	58	60	xxx
Frequency Operation-Emergency Spillway	% chance	2.5	2.5	3.3	3.1	2.4	2.5	xxx
Size of Conduit	In.	24	36	36	24	24	24	xxx
Emergency Spillway Design								
Rainfall Volume (ESH) (areal)	In.	6.80	6.79	6.80	6.80	6.80	6.80	xxx
Runoff Volume (ESH)	In.	4.18	4.17	4.31	4.18	4.18	4.18	xxx
Storm Duration	Hrs.	6	6	6	6	6	6	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Bottom Width	Ft.	150	300	250	150	200	160	xxx
Velocity of Flow (V_e)	Ft./Sec.	0.00	1.85	3.50	1.40	0.00	0.00	xxx
Slope of Exit Channel	Ft./Ft.	0.0365	0.0670	0.0446	0.0850	0.1520	0.0630	xxx
Maximum Water Surface Elevation	Ft.	957.9	970.1	944.5	856.3	892.2	819.6	xxx
Freeboard Design								
Rainfall Volume (FH) (areal) (-hrs.)	In.	13.90	13.87	13.90	13.90	13.90	13.90	xxx
Runoff Volume (FH)	In.	10.86	10.84	11.02	10.86	10.86	10.86	xxx
Storm Duration	Hrs.	6	6	6	6	6	6	xxx
Maximum Reservoir Water Surface Elevation	Ft.	962.4	975.3	947.8	861.4	896.4	823.6	xxx
Capacity Equivalents								
Sediment Volume	In.	0.95	1.12	0.96	1.15	0.71	0.56	xxx
Retarding Volume	In.	4.32	3.94	3.40	4.05	4.30	4.22	xxx

1/ Crest of Emergency Spillway

2/ Volume for lowest ungated outlet includes anticipated borrow to be excavated below this elevation. This borrow volume is not included in the submerged sediment.

July 1973

TABLE 4 - ANNUAL COST

Kickapoo Creek Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures Numbers 1 through 6	45,240	1,190	46,430
Project Administration	6,280		6,280
GRAND TOTAL	51,520	1,190	52,710

1/ Price Base: Installation - 1973, O&M - Adjusted normalized prices, April 1966

2/ 100-years at 5.625 percent interest.

July 1973

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Kickapoo Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	10,450	3,280	7,170
Other Agricultural	9,470	2,150	7,320
Nonagricultural			
Road and Bridge	9,630	1,910	7,720
Subtotal	29,550	7,340	22,210
Sediment			
Overbank Deposition	6,200	2,140	4,060
Lake Granbury	3,480	2,220	1,260
Bailey Lake	500	100	400
Subtotal	10,180	4,460	5,720
Erosion			
Flood Plain Scour	8,670	2,790	5,880
Indirect	4,840	1,460	3,380
TOTAL	53,240	16,050	37,190

1/ Price Base: Nonagricultural damages - current prices (1973);
All other damages - adjusted normalized prices, April 1966

July 1973

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Kickapoo Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	More Intensive Land Use	Incidental Livestock Water	Secondary	Total		
Floodwater Retarding Structures Numbers 1 through 6	34,590	22,530	2,140	56,290	115,550	46,430	2.5:1.0
Project Administration						6,150	
GRAND TOTAL	34,590 3/	22,530	2,140	56,290	115,550	52,710	2.2:1.0

1/ Price Base: Nonagricultural benefits - current prices (1973); All other benefits - Adjusted normalized prices, April 1966

2/ From Table 4

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of 2,600 annually.

July 1973

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment for the watershed was developed by the Hood-Parker, Bosque, and Palo Pinto Soil and Water Conservation Districts assisted by personnel from the Soil Conservation Service field offices at Granbury, Stephenville, Weatherford, and Mineral Wells, Texas. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent conservation needs of the entire watershed. The quantity of each land treatment practice, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. The estimated number of acres, by land use, to be treated during the project installation period are shown on table 1. Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of flood damage reduction desired by local people.

Hydraulics and Hydrology

Hydrologic soil and cover conditions were determined by detailed mapping of 22 percent of the watershed.

Present hydrologic cover conditions were determined on the basis of the percentage of vegetative ground cover and litter. Future hydrologic cover conditions were estimated on the basis of the expected percentage of needed land treatment to be applied during the installation period and the probable effectiveness of the application.

Rating curves were developed, by water surface profiles as outlined in EWP Technical Guide No. 22, from surveyed valley cross sections located in joint consultation by the hydraulic engineer, economist, and geologist.

Project formulation, hydrology, was developed for present and with project conditions using procedures as outlined in Technical Release No. 20.

Water surface profiles and project formulation, hydrology, were developed by automatic data processing using the computer at the South Regional Technical Service Center.

The frequency method for evaluation was used to develop area and depth inundation tables and curves.

Engineering

Six floodwater retarding structures were selected for inclusion in the final work plan. The structure locations are shown on figure 4.

Sediment and floodwater storage, structure classification, and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27.

Multiple routings of both principal and emergency spillways were made to determine the principal spillway sizing, height of embankment, detention storage requirement, and to analyze the effects of release flows on downstream improvements such as highways and low water crossings. Least cost studies of designs were made for the planned floodwater retarding structures.

Geology

Soils and Foundation

Preliminary geologic investigations were made at the six planned floodwater retarding structure sites to obtain information on the nature and extent of embankment and foundation materials, types of materials in emergency spillway excavation, emergency spillway stability, and other problems that might be encountered during construction. These investigations were made in accordance with Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1966 and NEH, Section 8, Chapter 6. These investigations included hand auger borings and observations of valley slopes, alluvium, channel banks, and exposed geologic strata. Geologic maps and reports concerning the watershed and vicinity were studied.

Findings of these investigations were used in making cost estimates of the structures and to assure that sites selected are feasible for construction.

Site Nos. 1, 4, 5, and 6 are located on the outcrop of the Strawn Group which belongs to the Pennsylvanian System. The topography is rolling to gently sloping. Red shale is the dominant bedrock at these sites, but soft to moderately hard sandstone beds are commonly interbedded with the shale beds. Flood plain alluvium, which has moderate thickness, consists primarily of sandy clay, clayey sand, and silty sand. The alluvium will provide ample quantities of suitable materials for embankment construction within short haul distances. Minor foundation drainage measures will be needed at Site Nos. 4 and 6 where sandstone beds will be encountered in the foundations. Approximately one-third of the total emergency spillway excavation at Site No. 5 is expected to be rock excavation.

Site Nos. 2 and 3 are located on the outcrop of Lower Cretaceous sand, clay, and soft sandstone belonging to the Twin Mountains Formation.

As at the sites located on Pennsylvanian strata, the flood plain alluvium consists mainly of sandy clay, clayey sand, and silty sand, but the presence of gravel is more common. This is especially true at the base of the alluvium. The need for foundation drainage measures is anticipated for both sites. Suitable and ample borrow materials are available within

short haul distances. There will be no rock excavation in emergency spillways.

The preliminary estimate of rock excavation in the emergency spillway at Site No. 5 is 21,000 cubic yards. It is estimated that all emergency spillway excavation at Site Nos. 1, 2, 3, 4, and 6 will be common.

Detailed geologic explorations will be made at all sites prior to final design. Laboratory tests will be made to determine suitability and methods of handling foundation and embankment materials.

Sedimentation

Sedimentation investigations were made in accordance with procedures as outlined in NEH, Section 3, Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1966, and Technical Release No. 12, "Procedure-Sediment Storage Requirements for Reservoirs", January 1968.

Determinations of the 100-year sediment storage requirements for the six planned floodwater retarding structures were made according to the following procedure:

Detailed studies of soils, slopes, and cover were made within the drainage areas of three floodwater retarding structure sites.

Average annual sheet erosion, for both present and future conditions, was computed. The soil loss equation by Musgrave was used. Estimates of average annual sheet erosion within the drainage areas of the other three sites were based on the computed erosion rates.

Computations of gully and streambank erosion were based on estimated lateral bank erosion rates, bank heights, and channel lengths affected by erosion.

Sediment delivery ratio and trap efficiency adjustments were applied to computed average annual erosion to arrive at an estimate of the sediment volume to be deposited in reservoirs.

Allowances were made for differences in density between soil in place and sediment. These densities were based on estimated volume weights of 58 to 60 pounds per cubic foot for submerged sediment and 86 to 94 pounds per cubic foot for soil in place.

Allocation of sediment to the pools of floodwater retarding structures was based on sediment texture and reservoir topography. After allowances for differences in density between submerged sediment and aerated sediment, the allocations range from 84 to 92 percent in the sediment and sediment reserve pools and from 8 to 16 in the detention pools.

Flood Plain Sediment and Scour Damages

The following procedure was followed to determine the nature and extent of physical damage to flood plain lands and the effect of the project on these damages:

Borings were made along surveyed valley cross sections. Factors such as depth and texture of sediment deposits, soil conditions, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators. The widths of modern alluvial deposits and scoured areas along each cross section were measured and tabulated. Damaged areas were grouped by flood plain segments. Widths of damaged areas at cross sections and lengths of segments were used to calculate acreages. The damages were summarized by evaluation reaches.

A damage table was developed to show percent loss of productive capacity by texture and depth increment for sediment and by depth and width for scour. Due consideration was given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages. Adjustments for recoverability of productive capacity were made on the basis of field studies and interviews with farmers.

The estimated average annual sediment yield from each source (sheet erosion, gully erosion, streambank erosion, and flood plain scour) was based on detailed sediment source and scour damage studies. Sediment yields to evaluation reaches were computed for the following conditions: without-project; with land treatment measures applied; and with the combined program of land treatment and structural measures installed. The reductions in sediment yields were adjusted to reflect the relative importance of each sediment source as a contributor of damage.

The estimated reduction of scour damage due to installation of the project was based on reduction of depth and area inundated by floodwater.

Economics

Basic methods used in the economic investigations and analyses are outlined in the "Economics Guide for Watershed Protection and Flood Prevention", U.S. Department of Agriculture, Soil Conservation Service, March 1964.

Evaluation of Damages

For evaluation purposes, the flood plain was divided into two reaches based on significant differences in land use, drainage pattern, and

characteristics of flooding. About 45 percent of the owners and operators representing approximately 60 percent of the flood plain land were interviewed concerning flooding and flood damage; past, present, and intended future use; and yield data. Verification of information gained by interviews in the field was obtained from local agricultural technicians.

The frequency method analysis of damages was used, and the occurrence of more than one flood in a growing season was considered in determining crop and pasture damage. The computed damages were discounted for the recurrence with allowance for partial recovery of crops between floods.

Other agricultural damages to fences and farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected in the field and correlated with area and depth of flooding.

Road and bridge damages in the flood plain were based on information obtained from county commissioners, State highway officials, and supplemented by information from local residents.

Monetary damages to the flood plain from scour and overbank deposition were based on the value of production losses. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows. Reduction in monetary damages from sediment deposition was based on the effectiveness of land treatment measures, trap efficiency of planned floodwater retarding structures, and the average annual area flooded under each progressive phase of the project.

Sediment damages to Lake Granbury and Bailey Lake were determined by the straight line method. Estimated construction costs were used to determine the cost per acre foot of storage lost by sediment deposition in each structure.

Benefits from Reduction of Damages

Average annual damages within the watershed were calculated for conditions without a project, with planned land treatment, and after installation of the complete project.

The difference between the damages after the installation of a phase of the project and that before its installation constituted the benefit from reduction of damages creditable to that phase.

Evaluation of More Intensive Land Use

During field investigations, farmers were asked what changes had been made in their flood plain land use as a result of past flooding. It was found that some cropland has been returned to pasture as a result of flooding and crops less susceptible to damage were being planted. They were also asked what changes they would make in their use of the flood plain if flooding were reduced. Farmers indicated that when flooding is reduced, woods and brush will be cleared. This land, plus some

of the open pasture land, will be planted to hay and coastal bermudagrass.

Estimates of benefits from more intensive land use of the flood plain were based on changes indicated by farmers, land capabilities, and the general agricultural economy. Consideration was given for added damage expected to the higher value production from the remaining flooding. Additional costs of production, harvesting, and associated costs were deducted from the expected increase in production. Benefits were discounted to allow for a 5-year lag in accrual. Prices were converted to adjusted normalized price levels.

Incidental Livestock Water Benefits

Incidental livestock water benefits were evaluated for sediment pools of floodwater retarding structures. The annual benefits were considered to be equal to the annual equivalent costs, including maintenance costs, of providing the same water resource in numerous smaller livestock ponds. Benefits were discounted to allow for full level of use during the first 80 years with a gradual diminishing during the next 20 years to zero at the end of the evaluation period.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over the period of project life. No production in sediment pools was considered and the land covered by detention pools was assumed to be grassland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification.

Indirect Damage Reduction Benefits

Expenses associated with disruption of agricultural operations, interruption of travel, rerouting of school buses and mail routes, business losses and similar losses will be incurred. Indirect damages were estimated to be ten percent of the direct damage.

Secondary Benefits

Secondary benefits were estimated by adaptation of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in "An Input-Output Model of the North Central Region of Texas" which was developed as part of the Texas Interindustry Project, office of the Governor, Division of Planning Coordination, April 1972.

Increased employment resulting from the proposed project was estimated by the use of multipliers as calculated in "An Input-Output Analysis of

the Texas Economy Emphasizing Agriculture" by Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

Archeological

The watershed work plan has been coordinated with the Texas State Historical Commission and the National Park Service, USDI. An archeology survey of the floodwater retarding sites was conducted by the Department of Anthropology, Archeology Research Program, Southern Methodist University, under the direction of Mr. S. Alan Skinner as principal investigator. Due to the eroded condition of the archeological sites observed, no additional archeological survey work is recommended by Mr. Skinner.

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance study of Kickapoo Creek watershed. This report was valuable in work plan development pertaining to fish and wildlife. In addition to data presented in other parts of the work plan, the following is reproduced from the Bureau of Sport Fisheries and Wildlife reconnaissance survey report:

> The planting of native grasses and forbs in the sediment pool of the floodwater retarding reservoirs would increase the water's fertility and reduce its turbidity. Vegetation planted on the barren areas draining into the reservoirs also would improve fertility and reduce turbidity.
>
> The control of livestock entrance into the area and in and around the reservoir sediment pools would reduce fouling of the water and aid the growth of wildlife food and cover plants. When practicable, the sediment pools should be fenced and livestock water requirements supplied by providing water lanes to the pools.
>
> Landowners in the project area would be benefited if they consulted in Texas Parks and Wildlife Department regarding the fish stocking requirements of the new waters created by the project. Such consultation would discourage the introduction of undesirable fish species into the project's waters and would insure the best fish stocking rate.
>
> Land treatment measures which would aid wildlife are field border planting, hedgerow planting, wildlife habitat development, and wildlife habitat preservation. The planting of legumes or small grain winter crops in the Cross Timbers Land Resource Area would provide badly needed winter deer food and allow the deer population there to increase.
>
> In the areas where brush control is done, it should be carried out with wildlife habitat preservation and enhancement in mind. On rolling or flat areas brush can be controlled by alternating cleared strips no more than 2,000 feet wide with brushy strips approximately 300 feet wide. In addition, wildlife escape

corridors of brush should be preserved and steep easily eroded slopes should not be cleared. In general, about one-fourth of the area's existing brush should be retained as scattered tracts.

Losses of brush and timber resulting from the installation of project structural measures could be offset partly by planting shrubs and trees of value to wildlife at appropriate locations such as idle lands, eroded areas, streambanks, gullies, and around floodwater retarding reservoirs. The wildlife plantings also would aid in erosion control.

With increased fish and wildlife populations, moderately priced fee fishing and lease hunting could be expanded. In addition, progressive landowners could form a hunting and fishing cooperative and urban sportsmen could be sold annual permits entitling them to pursue their sport on lands owned by the cooperative members.

In view of the above, it is recommended that:

1. Native grasses and forbs be planted on barren areas in the sediment pools and on unvegetated lands draining into these pools.

2. The sediment pool of the floodwater retarding structures be fenced, if practicable, and livestock water requirements be supplied by providing water lanes to the pools.

3. Landowners seek the advise of the Texas Parks and Wildlife Department in the management and stocking of their reservoirs for fish and the management of those waters for wildlife.

4. The land treatment measures of field border planting, hedgrow planting, wildlife habitat development, and wildlife habitat preservation be included in the watershed work plan.

5. Legumes or small grain winter crops be planted in the Cross Timbers Land Resource Area to provide winter food for deer.

6. Brush control be done so as to preserve or enhance wildlife habitat by alternating cleared strips no more than 2,000 feet wide with brushy strips approximately 300 feet wide, by preserving escape corridors of brush for wildlife, by maintaining the brush on easily eroded slopes, and by retaining about one-fourth of the watershed's existing brush as scattered tracts.

7. Losses of woody vegetation due to the building of project structural measures be offset partly by planting trees and shrubs suitable for wildlife at appropriate locations such as idle lands, eroded areas, streambanks, and around reservoirs.

4-31130 11-73

8. Floodwater retarding reservoirs and farm ponds be opened to the public for moderately priced fee fishing.

9. Landowners consider the feasibility of forming a hunting and fishing cooperative, whereby members would sell annual hunter and fisherman permits to enter cooperative lands.

The above recommendations are in conformance with the USDA Soil Conservation Service Plant Sciences Memorandum-5, National Standards and Guides to Specifications for Conservation Practices in the Plant Sciences. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and, additionally, fish and wildlife benefits would accrue to the project.

A detailed study of the watershed by the Bureau of Sport Fisheries and Wildlife was not considered necessary at this time. Should the sponsors desire, the Bureau, in cooperation with the Texas Parks and Wildlife Department, would be happy to be of further assistance.

4-31130 11-73

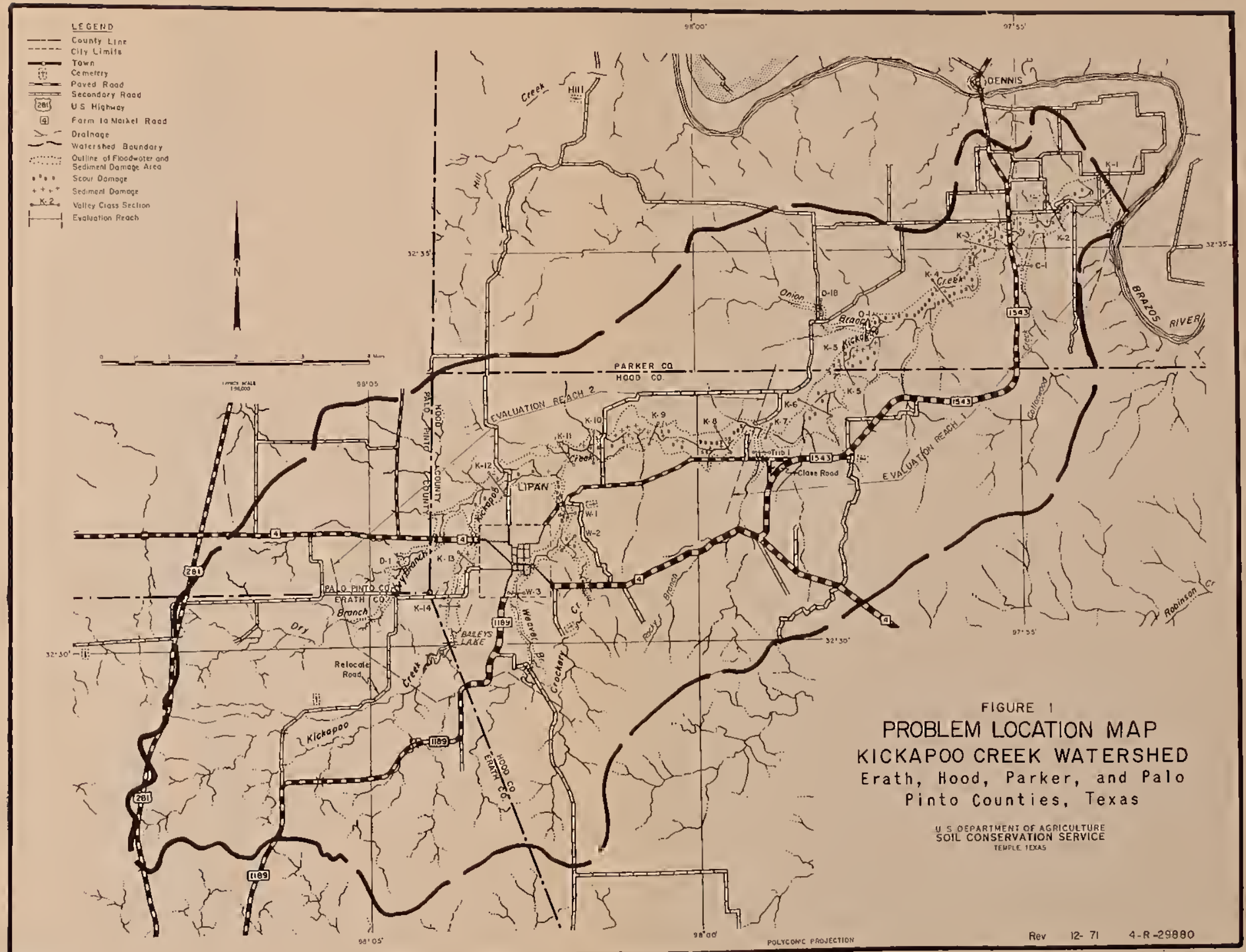


FIGURE 1

PROBLEM LOCATION MAP
KICKAPOO CREEK WATERSHED
Erath, Hood, Parker, and Palo Pinto Counties, Texas

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Rev 12-71 4-R-29880

Rev. 12-71 4-R-19698

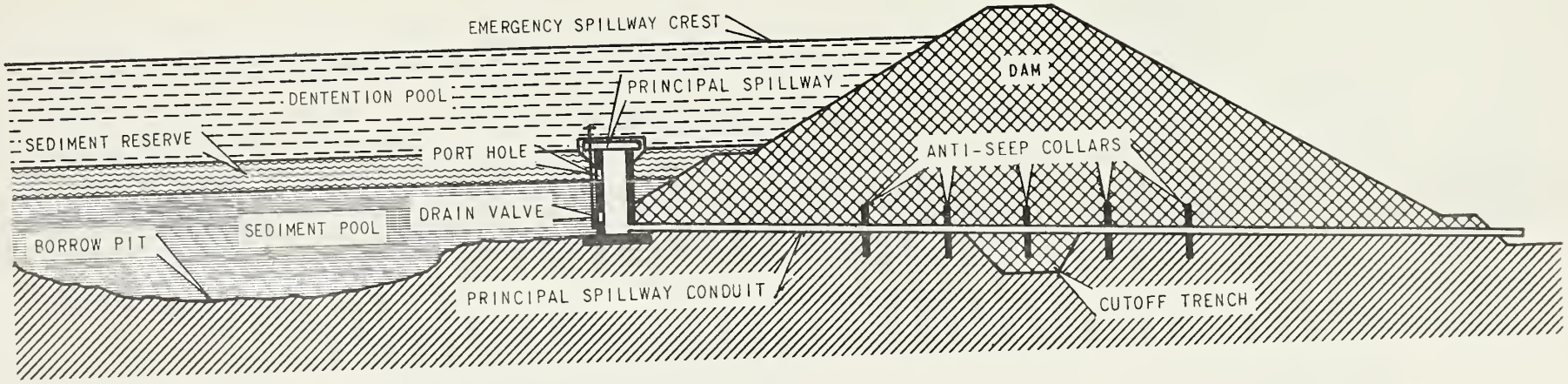


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

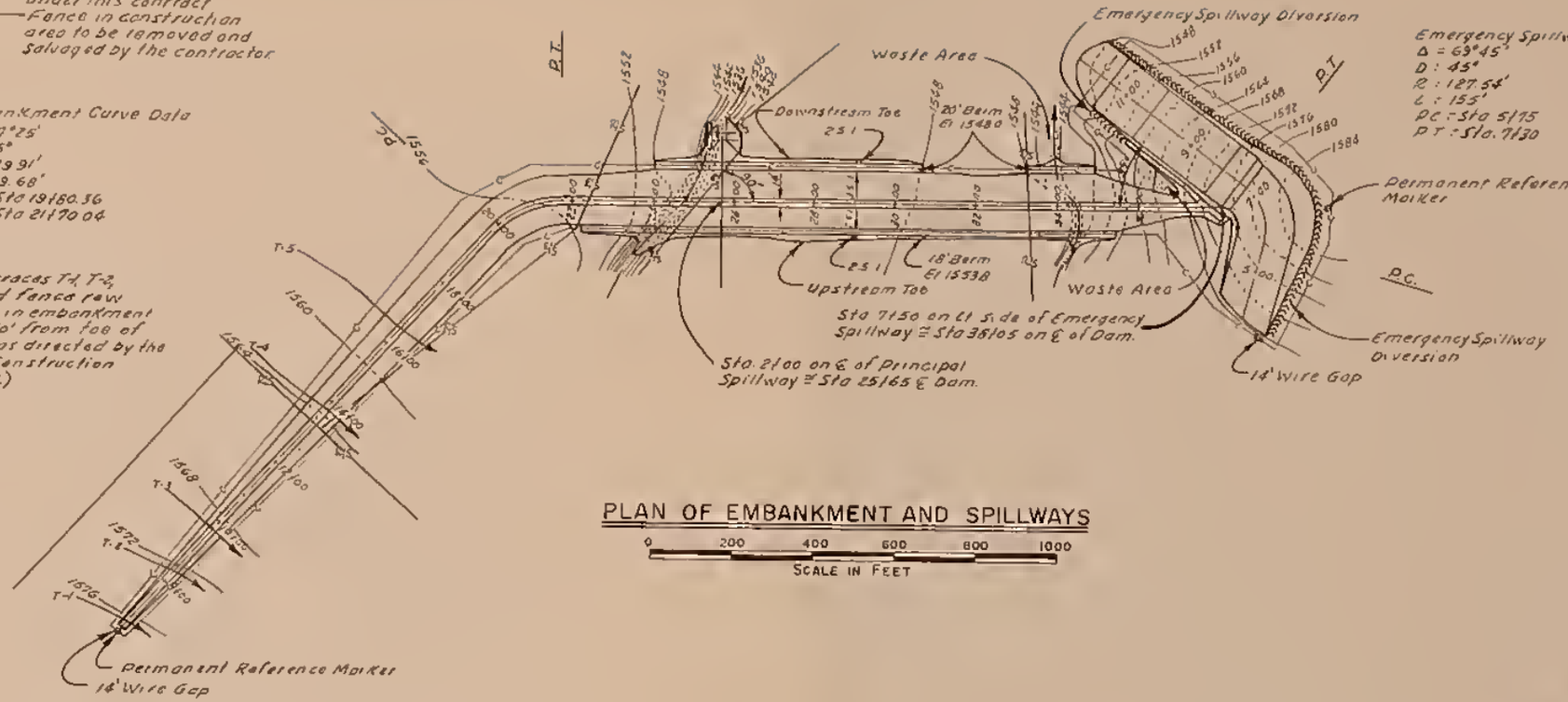
6-71 4-L-10,071-C

U. S. D A., SOIL CONSERVATION SERVICE
USDA-SCS-FORT WORTH, TEX. 1971

Fence Legend
—c— Fence to be constructed under this contract
—E/S— Fence in construction area to be removed and salvaged by the contractor.

Embankment Curve Data
Δ = 47°25'
D = 25°
R = 229.91'
L = 189.68'
PC = Sta 19+80.56
PT = Sta 21+70.04

Note: Field terraces T-1, T-2, T-3, T-4, T-5 and fence row shall be leveled in embankment fill area and 40' from toe of embankment as directed by the Engineer. (See Construction Specification 21.)



PLAN OF EMBANKMENT AND SPILLWAYS

0 200 400 600 800 1000
SCALE IN FEET

Emergency Spillway Curve Data
Δ = 69°45'
D = 45°
R = 127.54'
L = 155'
PC = Sta 5+75
PT = Sta 7+30

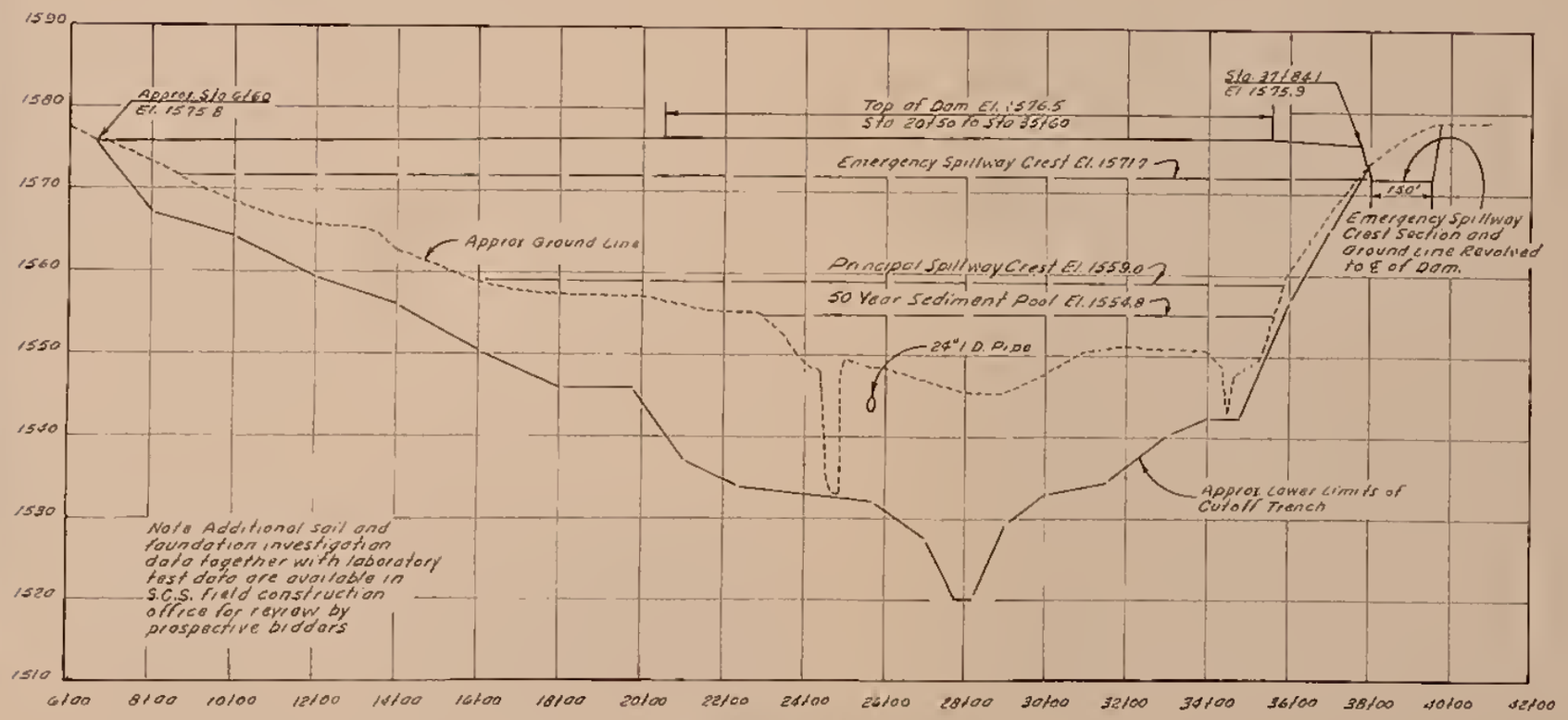
A minimum of 6" of topsoil shall be placed in the Emergency Spillway and on all Earth Fill Areas (See Construction Specification 26A)

Emergency Spillway Diversions shall have 13 ft minimum base width, 3:1 side slopes, and 18" effective height. Effective height may be secured by grading a channel across high points to reduce the height of fill required in low areas. Where a channel section is required, the minimum bottom width shall be 12 feet.

Stream Channel within embankment area shall be shaped and cleared of objectionable material. (See Sheet 13 and Construction Specification 21.)

Dozer pits excavated during Soil and Foundation Investigation and not removed by normal construction operations, shall be filled, leveled and graded by the contractor. (See Construction Specification 23A.)

All suitable materials within the limits of the Sediment Pool Area shall be used prior to enlarging the Borrow outside these limits as directed by the Engineer.



PROFILE ON ℄ OF DAM

Elevation	Surface Acres	Storage Acre Feet	Storage Inches
1544	0	0	00
1548	5.4	11	.04
1552	17.5	57	.23
1554.8	28.0	125	.50
1556	32.0	156	.63
1559	49	280	1.12
1560	54.7	329	1.32
1564	73.4	585	2.35
1568	103.2	938	3.76
1571.7	129.0	1372	5.50
1572	129.6	1404	5.63
1576	172.0	2007	8.05
Top of Dam (Effective) Elev.			1575.8
Emergency Spillway Crest Elev.			1571.7
Principal Spillway Crest Elev.			1559.0
Sediment Pool Elev. (50 Yr.)			1554.8
Drainage Area, Acres			2991
Sediment Storage, Acre Feet			965
Floodwater Storage, Acre Feet			1007
Max. Emergency Spillway Cap., c.f.s.			3174
Max. Prin. Spillway Discharge @ El 1571.7 c.f.s.			70

FIGURE 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT AND EMERGENCY SPILLWAY
PLAN AND PROFILE

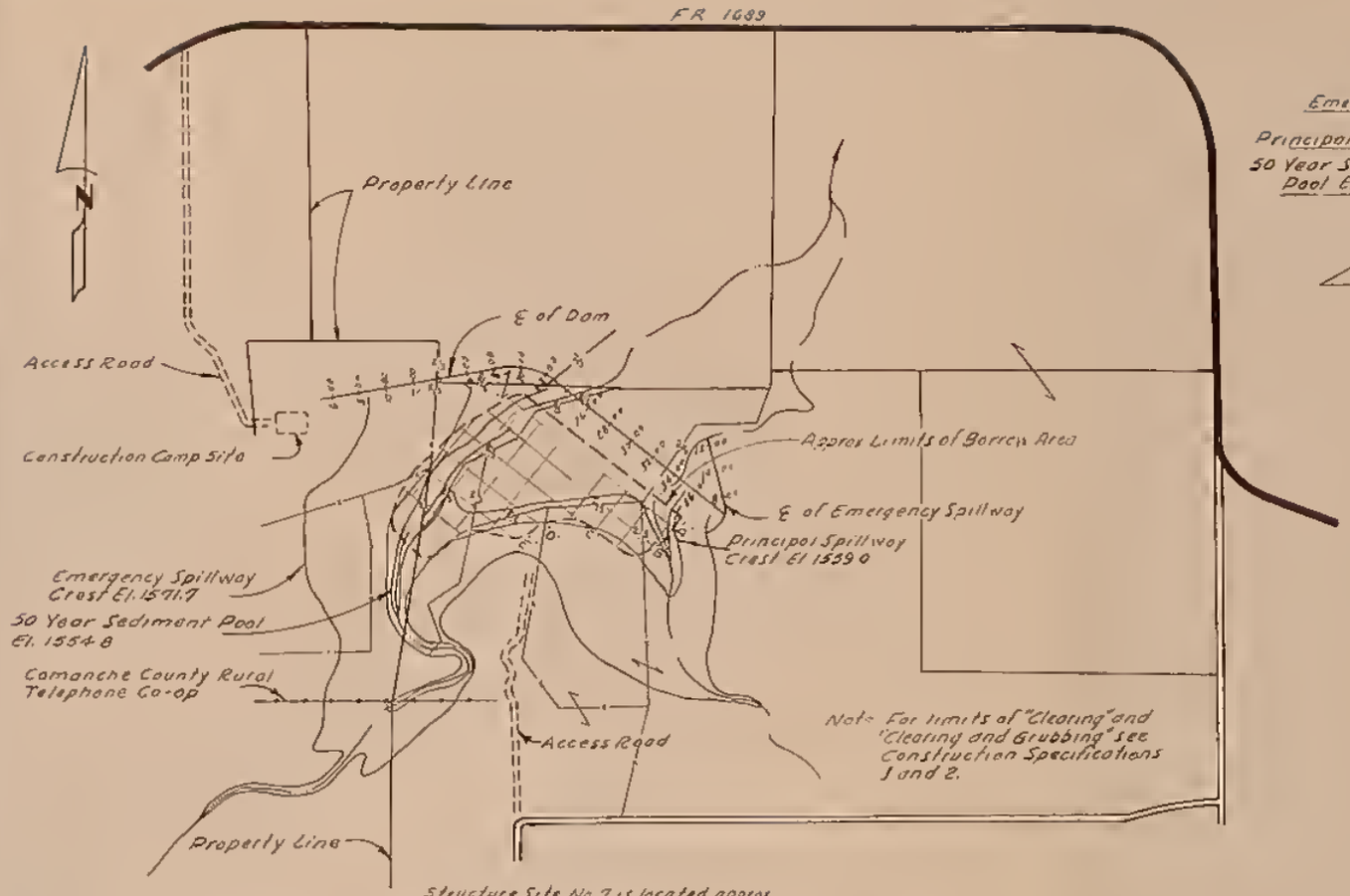
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed OLF & WLB	4-7
Drawn OLF	4-7
Traced OLF	5-7
Checked WLB & WDK	5-7

ECU

Sheet No. 2 of 13 Sheets

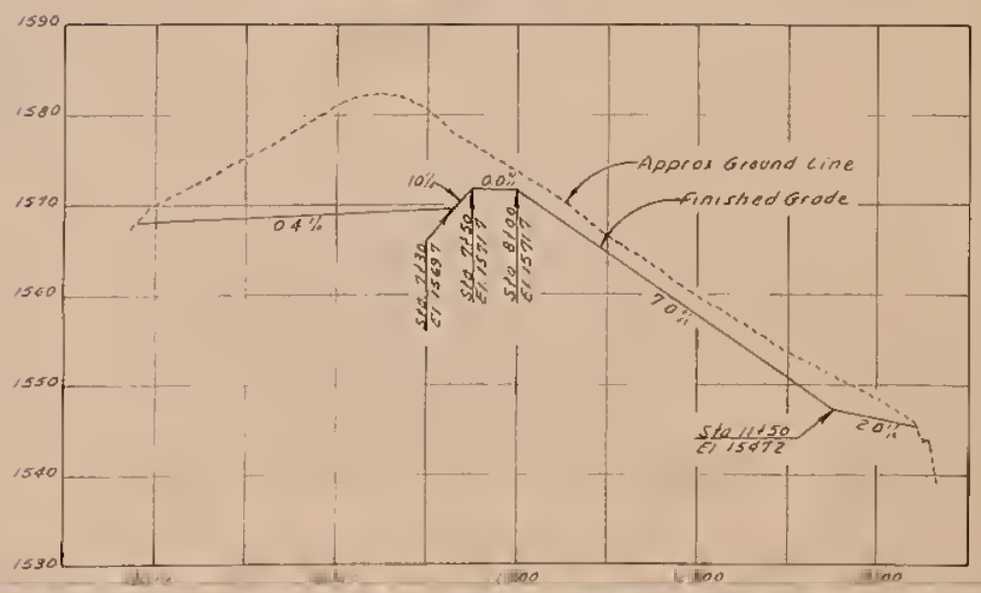
4-E-30,427



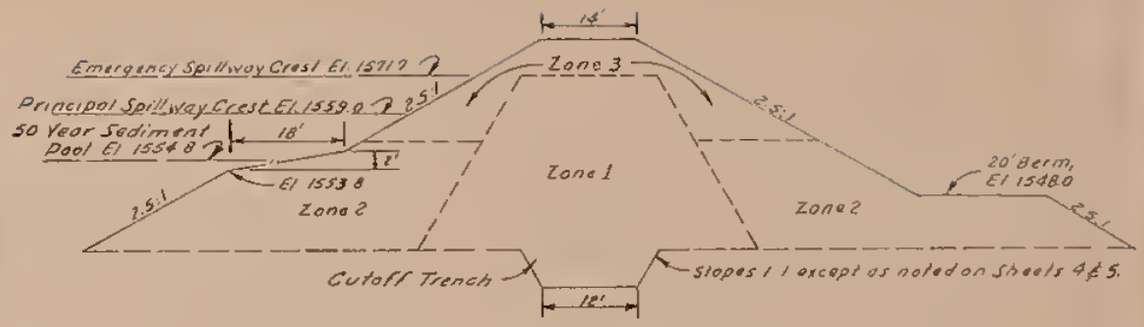
Structure Site No 7 is located approx 18 miles Northwest of Comanche, Comanche Co, Texas.

GENERAL PLAN OF RESERVOIR AND VICINITY MAP

0 660 1320 1980 2640 3300
SCALE IN FEET



PROFILE ON ℄ OF EMERGENCY SPILLWAY

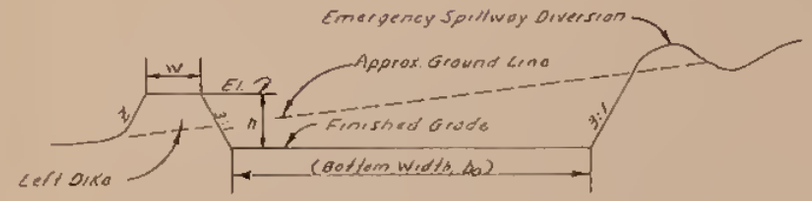


TYPICAL SECTION

Materials Placement Data									
Embankment Zone No 1/	Type or Unified Classification of Materials	Field Control Test		Placement and Compaction Requirements					
		ASTM Test		Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min Dry Density Percent of Field Test Max Dry Density	Moisture Limits, Relative to Field Test Optimum %	
		Num Set	Method					From	To
1 or Any	CL, Sandy Silty Clay	D-698	A or B	6"	9"	A	95	-1	Up
2	CL, CH, ML Sandy Silty Clay	D-698	A or B	6"	9"	A	95	Opt	Up
3	Sandstone	D-698	A or B	6"	9"	A	95	Opt	Up

1/ The zone boundaries shown in the typical section are approximate. They may be varied as permitted by the Engineer, to allow the use of all suitable and needed materials from the required excavations.

ZONED EMBANKMENT DATA



Left Dike: From Sta 7+30 to embankment, El 1575.3, W=12' and Z = 2.5:1.

From embankment to Sta 8+50, dike is transitional.

From Sta 8+50 to Sta 10+20, h = 2.5', W=12' and Z = 3:1. From Sta 10+20 to Sta 10+25, dike is transitional to diversion.

For payment purposes, transition from dike to diversion shall be considered as dike.

Bottom Width. From approx Sta. 4+00 to Sta 7+30, b_o = 138'. From Sta. 7+30 to Sta 7+50, b_o is transitional. From Sta 7+50 to approx Sta. 12+00, b_o = 150'.

Material forming dike shall be placed and paid for as "Earth Fill, Embankment" See Materials Placement Data and Construction Specification 23A.

TYPICAL SECTION - EMERGENCY SPILLWAY

FIGURE 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN OF RESERVOIR AND SECTION—ZONED EMBANKMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	D. C. T. W. S.	4-7	Approved
Drawn	D. L. F.	4-7	Title
Traced	D. L. F.	5-7	
Checked	W. L. B. L. J. K.	6-7	No. 3 of 5 Sheets

4-E-30,427

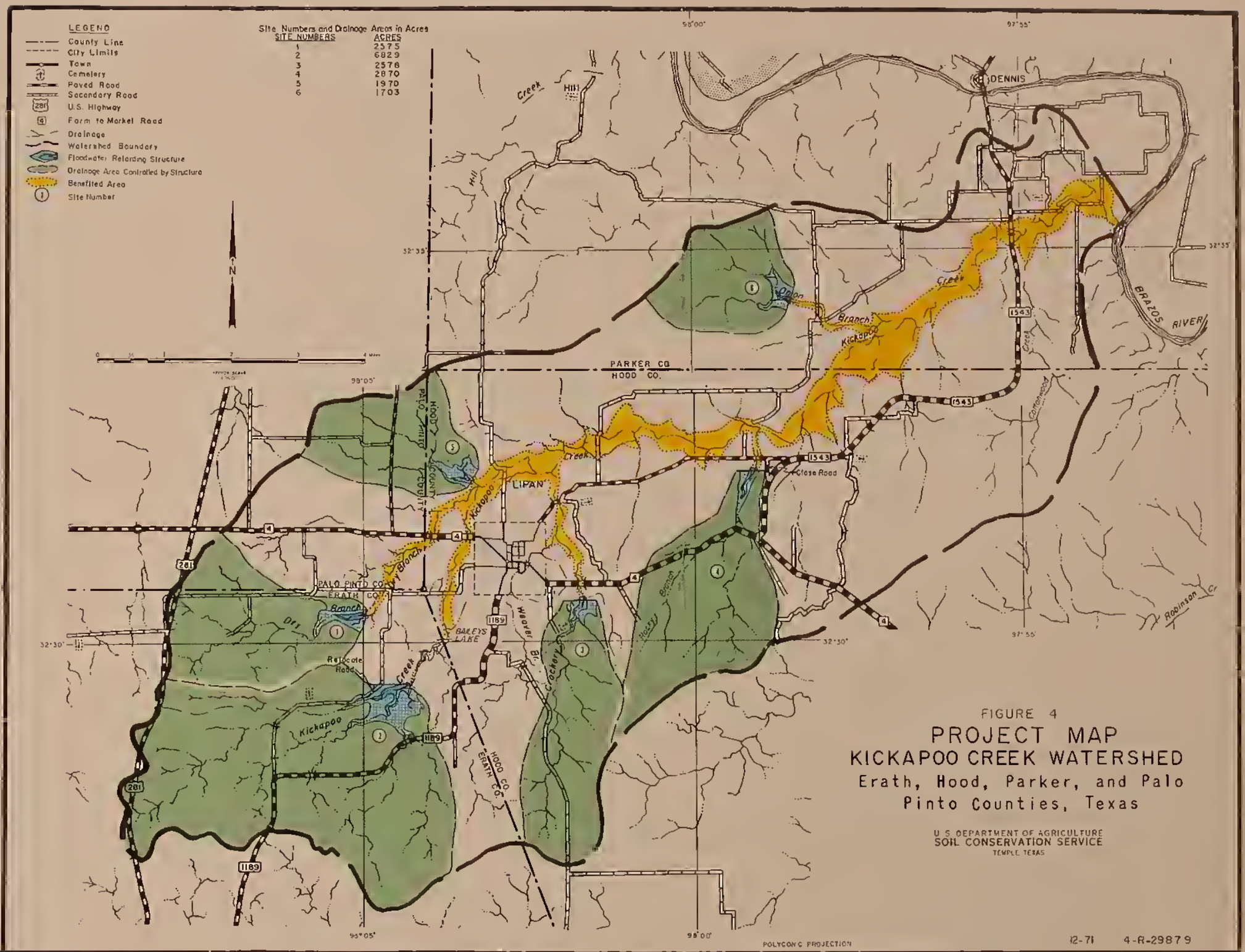


FIGURE 4

PROJECT MAP
KICKAPOO CREEK WATERSHED
Erath, Hood, Parker, and Palo Pinto Counties, Texas

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

12-71 4-R-29879

Base from General Highway Map

Rev 12-71 4-R-19698